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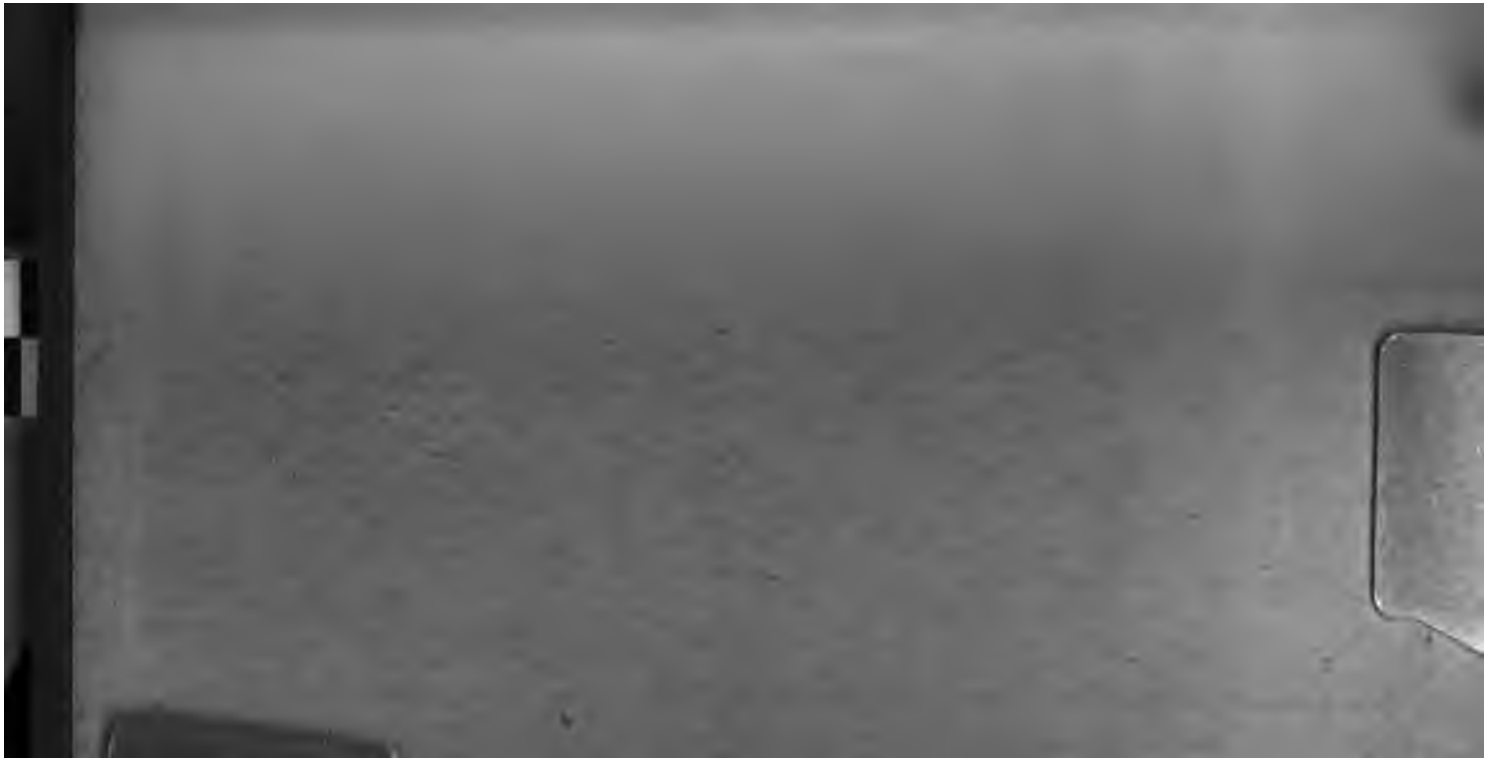
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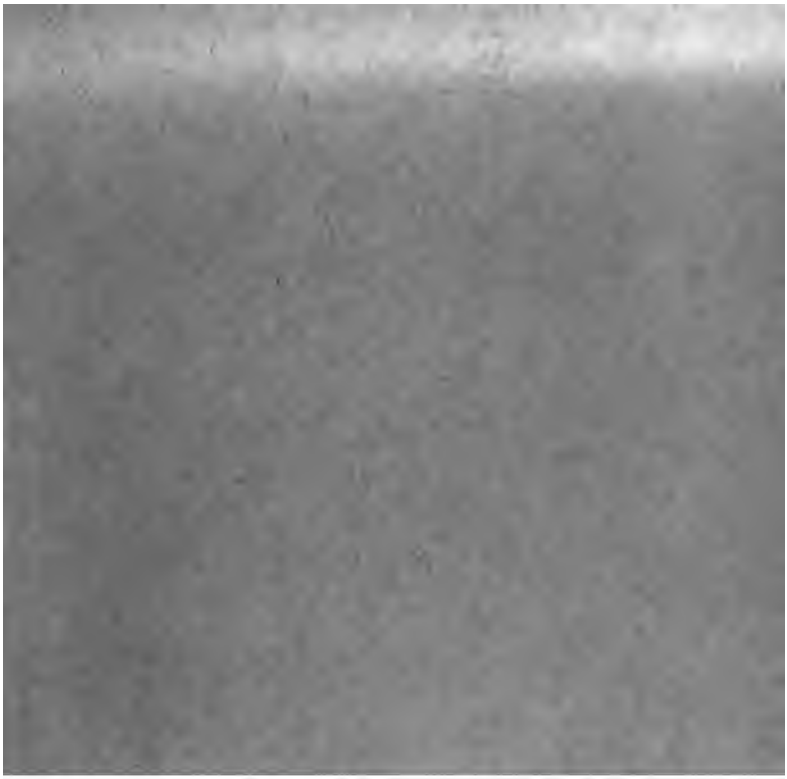
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A

THEORY OF SALTS.

PND



Salts
(T.C.)

A

THEORY OF SALTS:

T.C.

A TREATISE ON

THE CONSTITUTION OF BIPOLAR

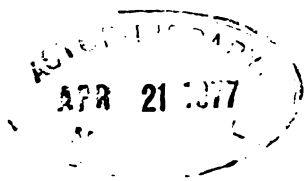
(TWO-MEMBERED)

CHEMICAL COMPOUNDS.

BY THE LATE

CHARLES BLACHFORD MANSFIELD.

London:
MACMILLAN AND CO.,
16, BEDFORD STREET, COVENT GARDEN.
1865.



"Videntur enim esse hæ duæ rerum tribus (Sulfur et rius) magnæ prorsus, et quæ universum occupant et pe Non est Sel aliquid tertium a Sulfure et Mercurio, sed ex utrisque per spiritum acrem devinctis."—*Francis Historia Sulfuris, Mercurii et Salis: aditus.*

PRINTED BY JOHN EDWARD TAYLOR,
LITTLE QUEEN STREET, LINCOLN'S INN FIELDS.

EDITOR'S PREFACE.

This book has been for many years a manuscript. Its author died a martyr to his Science nearly ten years ago, so that the *nonum prematur in annum* which he deprecated in his Preface, has been the fate of his volume; and that after its author's eye was closed, and when his hand could no longer retouch and modify, or, as it might have been, remodel its pages with the larger knowledge and the mellowing experience of intervening years implied in the apophthegm.

Before entering on the reasons and the causes of this delay, it may be well to sketch in outline the character and the scientific life of the remarkable man whose memory one fain would keep alive, but who died too soon to leave in written works an adequate expression of his powers as an original thinker or as a laborious student.

The author of this volume, Charles Mansfield, was one of those men whom it is not possible to forget. He fascinated all who came near enough

to him, and many whose acquaintance with
was only slight. In addition to the charm
genial and pleasant voice, he was endowed
manly beauty: clear blue eyes, shaded by a
but delicately formed brow, illuminated a
that generally had a tinge of sadness. A s
lithe frame, and an active but decisive gait,
spoke the man swift to act and confident in
aim; and his whole air and bearing were thos
one impulsively genial and generous, and thorou
true and genuine,—of one too, who, when onc
hand was on the plough, looked not back. W
ever there might be near him, whether among
friends that craved for sympathy, or from ano
class needing help as well, his heart by an
stinctive attraction was drawn to it, and such c
fort or material help as he had to give, he g
Nor did he stop to measure his gift by what he
to give. He feared not the tasks, if he lacked
power, of Hercules. If an Augean labour had t
done, he, with help if he could get it, if not sin
handed, would begin the doing it. The
people who in a district without gas and water, dr
death from sewage-tainted water, found fresh w
laid on, and with it life brought home to their do
and never, it may be, knew that no parish boar
rich charitable society had done the work, or t
the man to whom they owed it was a comparativ
poor student of chemistry, living on lentils

bread and water, that he might have the one luxury of thus staving off misery from at least some few dozen out of the thousands of the miserable. Such acts were not single, they were his habit. It is not wonderful, then, that men who really knew, never have forgotten Charles Mansfield.

But it is as the author of this 'Treatise on Salts,' as the chemist, or, more largely, as the "man of science," that we have to deal with him. And he was the "man of science," in the full sense of the word, if the range of the subjects he had studied, and still more of what he had laid down for himself as the scope of his future reading,—subjects which embraced no small portion of the area of human knowledge,—could make him so; and still more if the most original and independent mind give dignity and weight to character in a scientific man. Chemistry, though a most essential part, was still only a part of the scheme of education he had proposed to himself. He dealt with it as a branch of natural history, co-ordinate with those of zoology and botany. These latter treated of the relations of organisms and of the realms of life, while chemistry was concerned with "the mutual relations of inorganic bodies and of certain properties of organized bodies which do not expressly depend on their organic structure." He had begun with the sciences of life, and he seems to have had an early impulse to study particular

branches of those sciences. There were few men, fo
instance, who had studied ornithology more accu
rately than Mansfield had done. At one time of hi
life the birds were as his companions, and with
little telescope he was wont in long solitude to see
their most retired haunts, to watch their habit
and record in his note-book all their ways, and s
to beguile hours that else would have been sa
ones. With botany, too, he had a fair acquaintanc
He studied physiology in a severe and thorou
method, and went through the regular course
teaching at St. George's Hospital. But when h
turned to chemistry, this great science soon cam
to have for him a paramount attraction. Tw
reasons may be assigned for his attachment to i
In the first place, to speak in part in his ow
language, "because there is one point among th
acquisitions of chemistry that especially marks
as a science which enters more deeply into the lif
of things than most others, and that is the fun
damental importance it has learned to attach t
numerical expressions." "Number, indeed," h
says, "is the most spiritual of all our intellectu
conceptions. The constant prevalence of an app
rently arbitrary number points more directly t
the controlling power of some ever present orderl
Will, than all the clever contrivances that have bee
triumphantly quoted in evidence of the design of
Divine Mechanist. . . . That numbers involve th

key to the interpretation of nature must force itself on the conviction of every one who reflects upon the constancy with which they recur as the unvarying attributes of visible things." "It is when a branch of knowledge begins to recognise the value of numbers as elements of observation, that it begins to take rank as a science; when it has explained the meaning and relation of all the numerical quantities it has ascertained, it will be as a science complete." On this ground then chemistry presented itself to him as a science rapidly growing toward completeness. Again, by dealing as it did in all the different materials whereof the natural world is built up, this science seemed to him to possess a function, by virtue of which the chemist had, as his chief aim, the inquiry into "the plan on which, at least his department, if not the whole of nature, is put together; and so was justified in aspiring to give hints for the elucidation of the outward and visible harmony of the world." And this was the end towards which Mansfield's intellectual faculties were systematically directed and trained. To attain it involved the satisfaction of "a prevailing affection and desire of the human intellect,"—a natural yearning "after the comprehension of the harmonious plan or order on which the universe is constructed,—an order on which rests the belief that the universe is truly a representation to our ideas of a Divine Idea, and

is in fact a visible symbol of thoughts working
a Mind infinitely wise and good."

The pursuit of science, with the definite aim
investigating this great plan of the outward wor
was no fanciful sentiment or engrafted aft
thought of his later years. He began early in l
life, even as a Cambridge undergraduate, to spec
late and to read with a view to it; and though l
"schema mundi," as he was wont to say, was
tending and changing as his horizon grew wid
and only settled into the form here indicated abo
the time of his passing from the study of physiolo
to that of chemistry, he certainly entertained vie
similar to these, though he would doubtless have
pressed them in different language earlier in his li
Long before that period he had striven to attai
competent knowledge of the principles that ha
been followed by different writers in classifying t
animal, vegetal (as he would say), and mineral real
of nature. Besides an intimate acquaintance whi
he had attained with the classificatory systems
contemporary authors, his reading in this and
similar kinds of literature had been of a very wi
and curious kind, and extended back into the seve
teenth and even earlier centuries, from the writin
of Cuvier and Linnæus to those of Steele, Bech
Boyle, Hales, Bacon, Webster, etc.; and he h
often wandered into quaint by-paths, undeterred,
he was not even a little fascinated, by the mys

rious phantoms of alchemy and magic. No doubt something of quaintness is traceable, especially in his earlier writings, to these far-drawn and miscellaneous sources of his earlier ideas. By the ordinary practical student of chemistry, the year of the Hejira of Dr. Hofmann from Giessen to London may be taken as the epoch from whence he may date his science; and for him the history of the dawning life of that great science from Boyle to Liebig is sufficiently epitomized in the records of the last great Handbook. But Mansfield, though in the pursuit of the theoretical and of pure unpractical truth he gave one of the greatest of results to practical chemistry, was only content to study that science in full view of its past history, and in the hope of the light it might throw on the other departments of knowledge. That he did not despise the practical side of science, or what he called the "*beaver faculty*," of applying our knowledge and inventive powers to "making the rough world pleasant and comfortable," is sufficiently evident from the zeal and marvellous inventiveness which he showed in working out the practical uses of Benzole. But he never for a moment abandoned the cultivation of the higher faculty for the sake of this.

The opening of the Royal College of Chemistry in London offered him an opportunity which he knew how to value, of learning, in a sound and

scholar-like way, the practice no less than th
theory of chemistry, as it had been perfected
Liebig in the classic lecture-room and laborato
of Giessen. In Dr. Hofmann, the head of the ne
institution, he found one who appreciated his e
thusiasm, gave direction to his energy, and kne
also how to make of his pupil a valuable frien
So soon as Mansfield had passed through t
analytical course of the laboratory, and had beg
to look round for some subject on which to exe
cise his skill, Dr. Hofmann urged him to unde
take a task little inviting in its first aspect, a
still less so to one who had fairly entered on
details,—the fractional distillation of coal-tar, a
the complete separation of its ingredients. D
Hofmann had previously detected the presence
Benzole in that complex and uninviting mixtur
and Mansfield threw himself into the investigati
with all his zeal. Late into the night, for hou
after other lights were extinguished at the Colle
of Chemistry, the lamps under his retorts we
burning, and he might be seen there marking
his note-book the temperatures told by his the
mometers, and labelling the products he distille
while in the intervals of the processes he was bu
with a book, or his thoughts were occupied wi
some ingenious application of the substances
was winning from one refuse product of a va
manufacture. To this later period belonged, to

a series of observations and experiments on different forms of burners and draught chimneys for "gas" or other gaseous fuel, and for mixtures of different inflammable liquids to be employed in illumination. At length, after many long months of labour, he achieved the result to which he had been so long looking forward. He separated in pure condition the different members of a series of hydrocarbons, viz. Benzole, Toluole, Cumole, and Cymole, which he showed to exist free in the coal-tar. He proclaimed the first of them to be a considerable and important ingredient in that product, and at the same time, in his humorous phrase, "the genius of the family." He invented also a beautiful method for economically distilling it.

Mansfield had been brooding over the relationships of Benzole and of its companion ingredients in coal-tar, during the tedious progress of his fractional distillations. He saw clearly that the materials he was thus separating promised a rich harvest to theoretical chemistry and to the practical arts. In 1849 he embodied his prognostication in a little tract entitled 'Benzole, its Nature and Utility,' being the substance of an evening lecture at the Royal Institution, delivered on April 27th of that year.

Like the *sel mirabile* of Glauber, (or to enter on a career) like the *currus triumphalis antimonii* of

Basil Valentine, Benzole was to be the source new gifts to man,—it was the raw material, plentif and pure, from which almost a new department organic chemistry might be constructed. It wou be a cheap and invaluable source of light, an age for dissolving refractory resins, cleanse fabric produce a scent, be a subsitute for oil of bitter a monds, and serve a number of practical uses, to th development of all of which he at once devoted th resources of his inventive mind. Dr. Hofman already had made Aniline a classic word in che mistry, and for him Mansfield manufactured quan tities of that important substance. The process b which he made Benzole a source of illumination wa as exquisitely elegant as the light produced wa brilliant and white. This process consisted simpl in passing a current of air through the volatil liquid, whereoy the air became so charged with th vapour that, in a burner constructed on a simple an beautiful plan of his invention, the mixed air an vapour burned in the same manner as common gas but without smell or deleterious products of com- bustion. His readiness of resource was further illustrated in a most ingenious self-adjusting con- trivance for restoring to the Benzole the heat which was continually carried away from it by the vola- tilized vapour.

He patented his inventions, a process at that time involving considerable expense, and the usual

fate of a discoverer befell him in the loss rather than gain which resulted from his toil and ingenuity. His invention of the Benzole light will certainly find its application some day, though perhaps some less valuable and equally volatile hydrocarbon will take the place of the Benzole. But the vast results that have flowed from his discovery of an available source of Benzole, and so of Aniline and its derivatives, have but just begun to be gathered by chemists. More fortunate men are reaping large fortunes from the discovery or manufacture of these derivatives; and the results of these discoveries and of this new industry have added a new and splendidly rich character to every scene in which coloured fabrics are a feature.*

* The following graceful allusion to Mansfield's share in the work that has produced the beautiful dyes of our time is from Dr. Hofmann's article as reporter to the Jury for Chemical Products in the Exhibition of 1862 (page 123):—

"It was in 1848 that Charles Mansfield, in an experimental inquiry carried out in the Reporter's laboratory, showed that an inexhaustible supply of this substance might be obtained from coal-tar. It was Mansfield who for the first time prepared from coal-tar considerable quantities of Benzol in a state of absolute purity, and it is to him, therefore, that we are mainly indebted for having opened a practical source of this hydrocarbon, and for the industrial advantages which have subsequently flowed from that source. These advantages, alas! so far as we owe them to Mansfield, come to us in the form of a bequest, for they cost their lamented author his life. It was during the preparation of a larger quantity than usual of Benzol, in order to its more perfect

A comprehensive treatise on the Classificati
of Salts, with a complete and satisfactory nome
clature, would at any time be hailed by the ch
mist as a valuable addition to the literature of h
science. But such a work should be written with
full knowledge of the whole progress of chemic
thought up to the day of its publication. Th
Work now issuing from the press is not put fo
ward as aspiring to satisfy this want. It was wri
ten ten years ago; but whatever acceptance an
welcome, beyond what is personal to its autho
chemists may accord to it, they are more likely t
accord now than they were at the time it was le
as a posthumous manuscript; for its author die
at a most critical moment in the history of Chemi
cal Philosophy. The great work of Gerhardt, wh
so soon followed him, was only half issued, and it
fourth volume, which may be said to have give
force and direction to the strong rising current o

purification, that this highly-gifted young chemist and noble
hearted man met with the frightful accident which caused hi
death. In him science lost one its most ardent and most promis
ing cultivators. 'It would be wrong,' says his able biographe
(Chem. Soc. Quart. Journ. viii. 111), 'to estimate the man by
what he had actually given to the world. He was cut off at an
age when, with his varied gifts, it would have been easy for him
to have completed an ordinary life's work. He had proposed to
himself a task so broad, that the time failed him to do more than
lay the foundation for it.' The kindly reader will pardon this
passing tribute to his genius and devotion, whose life was lost in
winning the victories which his friend is now charged to describe."

a new chemical theory, did not appear till after the terrible event that left to other hands than its author's the publication of this book.* Had it been otherwise, few who knew Charles Mansfield, and few who may read his book, will doubt that its form would have been considerably altered before it went forth finally to the world. For it was but a few months after his death that the matured form of Gerhardt's views was announced, and became accepted with a surprising unanimity by the foremost men among working chemists, to whom it was the embodiment of principles with which many were already familiar. Whether or how completely Mansfield would have been a convert to this "new philosophy" it is very difficult to say. The want of exact uniformity, even after the labours of Regnault, in the atomic heats of elements, and the often-cited exceptions to the law of Dulong and Petit, gave, in his judgment, an uncertainty to the use of the principle involved in that law, that tended to preclude its being used as a very satisfactory guide for the determination of what should be deemed a chemical unit. For a similar reason he rejected the view of Berzelius, that identified the quantity commensurate with the gas volume

* Nor was it otherwise with regard to the remarkable work which Dr. Odling gave to the English language as a posthumous embodiment of the views of his friend and teacher, the *collaborateur* of Gerhardt, Auguste Laurent.

with the chemical atom. To this also the
were exceptions, and the view to which he he
namely, that purely chemical considerations, a
the properties and relations of different chemi
compounds, were the best and safest clue
their anatomy and constitution, was inconsiste
with such a law. But the simplicity of the sy
tem of types as propounded or developed by G
hardt, and the key it furnished for the indic
tion of precisely that sort of analogy among ch
mical compounds which Mansfield was ever
search of, would certainly have offered a gre
temptation for its acceptance to his mind. T
indifference of the Unitary school he attacked
the polar nature of salts, and its giving to electr
chemical decompositions no place at all in its sy
tem, induced him, on the other hand, the mo
strongly to urge his view, that the voltalytic for
was of paramount importance, both as evidenci
the existence of salts as a distinct class amo
chemical compounds, and at the same time as bei
a guide to the true interpretation of the sali
character.

The remarkable feature of Mansfield's book
it was left by him is the ingenious manner
which he has carried this idea through a va
range of chemical compounds, very few of whi
have really undergone voltalysis, and the re
beauty and simplicity, notwithstanding its app

rent complexity, of the system by which he represents salts even when they offer the most complicated analytical results. His idea of Epistyles and Epibases by which the polar structure of the true typical salt-element (or Endohale) is faintly echoed, as it were, in substances appended like wings (or Epistyles) to its electro-negative, or (as Epibases) to its electro-positive side, is an idea that may yet be taken up by chemists, and be found not inconsistent with a uniformity of volume in the entire molecular group forming the polar structure.

Few things are more striking in the history of sciences, and prominently in that of chemistry, than the periodical recurrence to ideas that have been superseded, and the acceptance at a later time under a new form, or from a point of view with a wider horizon, of theories that had been discarded, because their application was not universal, and because they had been found in their generation to be one-sided. The history of the terms, the symbols, and the numbers that have been adopted at different times to express a chemical unit, is strikingly illustrative of this. The oscillations of chemical thought have, in this respect, been rapid and somewhat fitful, from the atom of Dalton to the (two-atomed) equivalent or molecule of Berzelius and of Gay-Lussac, and back again to the weight-equivalent of Gmelin, which in turn was super-

seded by a restoration of the older views of Berzeliu
and Ampère, as seen in the new light that flashe
on them from the mind of Gerhardt. But on
thing is also certain in regard to these oscillations
like those of light itself, they are the expression o
a forward progress, simultaneous with their later
swaying from one view to its opposite. Thus, i
was not the molecular view of Berzelius merel
that was revived by Laurent and Gerhardt, bu
one that to Berzelius himself would have been
new chemistry. And so if a still newer che
mistry is now again taking the place of that o
Gerhardt, it is not that the science of Gerhardt i
superseded. While greater importance is given t
the law of the equality of the atomic-heat value
of elements, our language and our ideas at the sam
time take due cognizance of the law of Ampèr
(and of Berzelius) regarding the volume-relation
of the gaseous molecule and the chemical atom
And also the argument, the fundamental argu
ment it may be said, employed by Cannizzaro (an
Wurtz) in our day in determining the atomicit
of the elements, is founded on the paramount im
portance of chemical relations, and in consequenc
on the complete accordance of symbols and for
mulæ deduced from purely chemical considera
tions with those arrived at by comparison of th
molecular weights, the atomic-heat values, and th
isomorphous or other more purely physical cha

racteristics of the elements and their compounds. And thus in turn the terms atom, molecule, equivalent have found new or corrected definitions; but the formulæ nearly universally adopted by chemists are still built on the Unitary plan. The theory of types has absorbed all our ideas regarding the anatomy of compounds. It has attached no significance to the saline character. The idea of a salt has passed into the shade with the electro-chemical theory of Berzelius. But may not that idea too be some day again brought forward, and rehabilitated in the garb of an advanced and many-sided knowledge? Long ago the division of an oxygen or sulphur salt into an electro-polar couplet of oxides or sulphides—the view of Berzelius—had given way to the conviction, first suggested as a theory by Davy, that its true line of electro-chemical cleavage was to be drawn between an electro-positive elementary metal or compound molecule, and an electro-negative element or compound molecule. Oxides, chlorides, and all analogous compounds thus fell under one category with salts. It seems, therefore, inappropriate to condemn all belief in the saline constitution on the ground that the Berzelian theory of it was erroneous, or even because Chlorine (for instance) can be found on the electro-positive side.

Mansfield, then, wrote this book to defend the principle, that the facts of voltaic decomposition

afforded the true indication, if properly interprete
of the nature of the saline structure, and of th
atomicity, to use a modern phrase, of the elemen
that built it up; and he held that this structure
form of constitution is only one, but a most im
portant one, among the types of constitution o
which chemical compounds can be moulded. No
that chemical philosophy is rapidly accepting th
views originally propounded by Cannizzaro, an
not only recognizing much of what Mansfield con
tended for,—recognizing, in a word, the paramoun
importance, as grounds for determining the atomi
unit, of purely chemical data, not as contraste
with, but as borne out or modified by physica
considerations; and now that the metals, with a
few exceptions, are returning to the kind of equi-
valence as compared with oxygen that they for-
merly enjoyed, and for which in the main Mans-
field contended,—it may be that his book will
possess an interest that in a former day it would
certainly have failed to ensure, when the tide of
opinion ran deep and strong in favour of the uni-
valence, or, more correctly speaking, the, as com-
pared with oxygen, semivalence of so large a num-
ber of the metals, and of the subordination of all
chemical arguments to an iron law of voluminar
equivalence founded by Gay-Lussac, and inter-
preted by the school of Gerhardt.

But there is one principle in this book that will

certainly repay any thoughtful man for the trouble of reading it, independently of its general suggestiveness, and that is the remarkable precision with which Charles Mansfield uses his words. Many of his terms, or his limitations to the meanings of words now current, might be adopted with advantage in the science. Among the former may be mentioned the terms* Attachment, Style, Base, Thyle, Costirpial, Coserial; among the latter may be instanced Body, Substance, Antilogue, Ammonine, and indeed many others.

The origin of this volume appears to have been a course of lectures on the Metals which Mansfield was invited to give in the laboratory of the Royal Institution, in the year 1852.

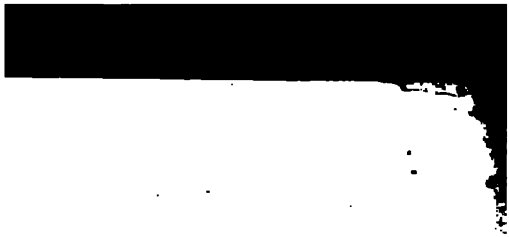
These lectures had for their object to review the chemical characteristics of this group of elements,† and to illustrate an ingenious principle by which Mansfield had endeavoured to arrange them. This

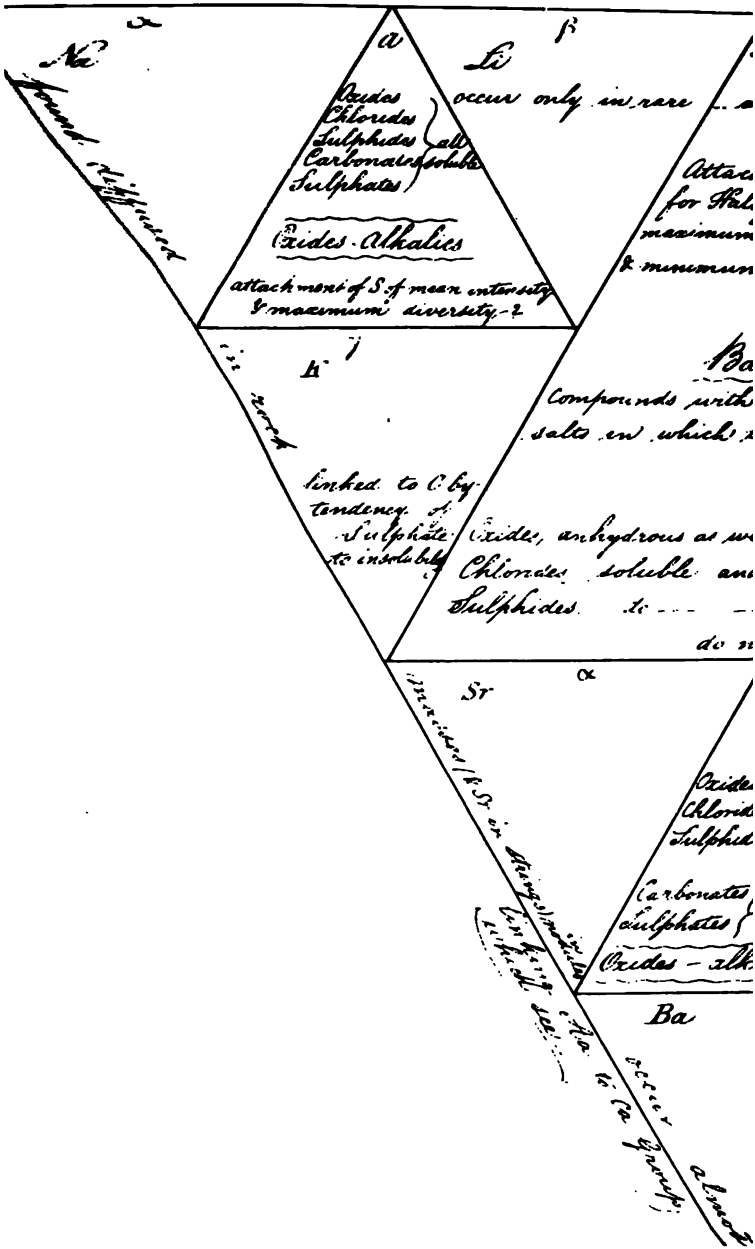
* The table in p. 546 will serve to convey at a glance the view Mansfield took of the "anatomical structure" of a salt, and the sense in which he used the various terms he so logically coined to express its several members. These and other terms will also be found in the Index.

† The representation here attempted of Mansfield's arrangement of the elements is necessarily imperfect, being constructed from contemporary notes of attempts made in conjunction with its author, with a view to a classification of the elements and their compounds.

so-called "affinity") with high specific gravity
eminently metallic character and low specific
the direction C would be that towards whi
triad of elements or groups such as are the
viest and most easily reduced would freque
gravitate; while A would indicate the directio
which we should look for the more alkalin
basic or less acid-forming characters, and B
towards which those would group themselves
are the, *comparatively* speaking, most acid-form
elements or groups of them in each triangle.
the classification of the metals he chose the an
gies in the characters of the oxides, sulphides,
chlorides, as indicating the characteristic on wh
the families were arranged; the general natur
the salts formed by the metals, whether as b
or as acid-forming ingredients in them, he took
the foundation of his generic divisions.

That the result should be imperfect was w
would be expected at the hands of any one deal
with an incomplete science; and with the m
perfected chemical theory of the present day
garding the atomicity of the elements, a far m
complete grouping of these bodies on Mansfie
plan might be produced, than that appended
this preface. That it was imperfect its aut
well knew. But he aimed at an approximat
to a complete system, and he promised to him
at a future day to write on the whole subject




Na
found
a
Oxides
Chlorides
Sulphides
Carbonates
Sulphates
all soluble
Oxides Alkalies
attachment of S. of mean intensity & maximum diversity - 2
β
Li
occur only in rare
Attac
for Hal
maximum
& minimum
Ba
Compounds with
salts on which
linked to C by
tendency of
Sulphate
to insolubility
Oxides, anhydrous as we
Chlorides soluble an
Sulphides
do n
Sr
Oxide
Chlorid
Sulphid
Carbonates
Sulphates
Oxides - alk
Ba



of observation and classification, ought to set the example of trying it.

In several parts of the work I have been forced into giving a controversial turn to the discussion; in some I have found myself assuming the tone of a critic upon the work of other chemists. I trust that my remarks are not so couched as to give offence to any who may notice them. In maintaining the theory of the constitution of salts which seemed to me most accordant with nature, I was brought into direct collision with the antagonist theory of MM. Gerhardt and Williamson. I have ventured to dispute the conclusions of these authorities, though entertaining, as must every follower of modern chemical progress, a warm admiration for the genius which inspires their laborious industry.

It may seem ill-advised that an obscure writer who comes forward with a proposed reform in one hand, should hold up the other to oppose changes advocated by authorities publicly placed most favourably for the introduction of innovations. But it must be remembered that it is reform which I suggest, and that it is revolution which is insisted on by the school which I resist. As the world advances, reforms are ever necessary, revolutions rarely, and only when orderly reform has been obstructed. The advocates of the old Binary theory of salts have neglected to reform their nomencla-

gress of chemical thought at that important mo
ment in the history of chemistry, there can b
scarcely a doubt. He had, indeed, put the manu
script into a publisher's hand with a view to pub
lication, but its form was that of a rough copy
For it was in a state so interlined, and as it wer
tessellated with alterations (often fundamental) o
old matter and the intercalation of new, that i
could not be used, even if it had been so intended
as copy for the printer.

After the catastrophe that ended his life, hi
friends—men who had gathered round his grave
and had laid there one to each and all of them
dear as a brother—undertook the task of recopying
the whole of the intricate manuscript. It fell t
the lot of the least worthy of them to conduct i
through the press. To those who so helped him
he is deeply indebted. To none but the Editor is its
late appearance due. The causes of the delay are
in part, entirely personal to him, originating in
changes in the direction of his occupations and in
much call on his time by other duties. It is also not
a little due to the difficulty of the task. But the
chief cause that has checked his progress has been
the conviction, that the tide of opinion on which the
Unitary, or rather the volume- and type-chemistry
of Gerhardt has been borne along, from the time
the manuscript came into his hand, had set in
far too strongly for this little book to make head-

way in it. He has always believed in the advent of a day when that tide would ebb, a day which has perhaps arrived. At any rate the arguments of this book are more likely to be calmly read and considered now than they were seven or eight years ago, and whatever of real truth or force they might have claimed eighteen months after February 1855, they assuredly will convey to the minds of chemists in 1864.

No chemist will peruse this book without feeling that he is in the presence of an original thinker, whose pages are continually suggestive, even though their general argument may not be entirely concurrent in direction with that of modern chemical thought. The bud, if not the fruit, is there; and it enfolds a promise, one part only of which is fulfilled, and that incompletely, in this treatise. The larger part was to have included a general view of chemistry and the relations of all chemical compounds, and to have been ultimately extended to a "classification of all natural things."

But this promise, alas! is to remain for ever unfulfilled. For man proposes, but it is not he who disposes.

N. S. M.

April, 1865.



AUTHOR'S PREFACE.

The following pages contain the expansion of some notions which were originally embodied in a course of lectures delivered in 1851–52, in the Laboratory of the Royal Institution of Great Britain. The subject of these lectures was the "Chemistry of the Metals." The doctrine of salts is so intimately connected with the natural history of metals, that it is impossible to discuss these elements chemically without continual reference to the construction of saline compounds. The terms, then, which are applied to salts, and to the members of which they are composed, are the tools most essential to the handling of the subject of metal chemistry.

To perspicuity in the transfer of thought from one person to another, if not to the comprehension of a matter in the mind of a single thinker, clearness and precision of language are absolutely necessary. It was therefore requisite for my purpose that I should have a set of terms applicable to the chemical anatomy of salts, each of which

My book is primarily divided into four parts. The first of these is introductory, treating of the nature of salts generally, and defining the subjects of the two succeeding parts. The last of these four is conclusory, containing a recapitulation of the chief points which I have sought to establish in the preceding two parts. The second part discusses the voltanegative members of bipolar or saline compounds, those members which are specifically characteristic of acids; the third treats of the voltapositive members of salts, those to which the various alkalies and their analogues owe their peculiar energies. There is not so just a balance between these two larger parts of the book as I could desire. The second part is written with greater attention to detail than the former. The reasons for this want of symmetry have been these. Firstly, I have been led somehow or other to take a livelier interest in such bodies as alkalies, "alkaloids," and "bases," than in "acids." Secondly, the boundaries of our knowledge have been more remarkably extended of later years in the direction of the "bases" than in that of the acids. It is mainly to the discoveries of my instructor and friend Dr. A. W. Hofmann that the recent rapid advance of the chemistry of the complex bases is due. Indeed, without the splendid results which his researches have yielded, it would have been impossible, not only to have attained with respect to

these molecules those general notions which I have here sought to illustrate, but to have made any coherent generalization as to the nature of one of the largest and most beautiful classes of compounds.

I should add, that as this third part of my book was written last, it has received a somewhat different complexion from that of the former. For, as I entered further into the subject, it became more interesting, and my notes became more and more diffuse, and my illustrations more detailed. Perhaps I ought to rewrite the first part, which was written before the plan of the book was quite matured, so as to bring it into parallelism with the latter. But I have no time for the work; and if I did it, I should then probably be more discontented with the other part than I am at present, and then there would be more repair to be done,—first a new blade, then a new handle to the old knife, and so on. But this would be unprofitable delay; the maxim "*nonum prematur in annum*" was never written by the poet with a view to treatises on science for the second half of the nineteenth century.

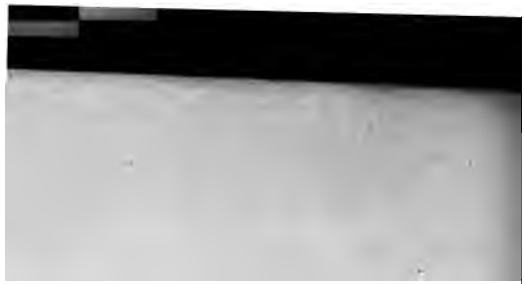
C. B. M.

Weybridge, Feb. 5, 1855.



ERRATA.

Page 9, line 3 of marginal note, *for* mere *read* more.
„ 17, line 25, *for* (S,O_3O) *read* (S,O_3).
„ 23, last line, note, *for* H:I *read* K:I.
„ 44, line 5, note, *for* Mellenide *read* Mellonide.
„ 49, „ 1, *for* Na:O;H:O *read* Na:O;H,O.
„ 67, „ 2, marginal note, *for* on *read* or.
„ 79, „ 5, see correct figure on page 101, line 8.
„ 81, „ 5, note †, *for* either the *read* either of the.
„ 81, „ 9, *for* B′ (and) H′ *read* B (and) H.
„ 86, „ 7, *for* O,H,O *read* O;H,O.
„ 86, „ 10, *for* owes it, *read* owes its.
„ 87, „ 9, *for* $H_2;Cy_2;Fe,Cy$ *read* $H_2:Cy_2;Fe,Cy$.
„ 91, „ 8, *for* Cloric *read* Chloric.
„ 95, „ 18, *for* $C_3H_4O_2S$ *read* $C_4H_3O_2S$.
„ 103, „ 12, *for* Am *read* Au.
„ 107, „ 12, *for* Thaline *read* Thalire.
„ 118, „ 8, note, *for* (C_8H_9) *read* $(C_{10}H_9)$.
„ 124, last line, *for* $C_2H;(C_2)_4(C_2H_2)_2$ *read* $H,(C_2)_4(C_2H_2)_2$.
„ 131, line 21, *for* Kalibenzite *read* Sodibenzite.
„ 312, in the pagination, *for* 310 *read* 312.



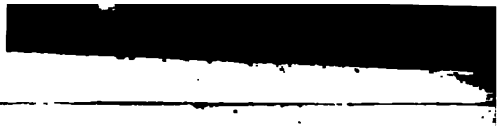
he general anatomy of salts was without any regular nomenclature. However, I am not disposed to affect much bashfulness in this matter, for I am so convinced that the time is come for infusing some new blood into our effete nomenclature, that since no professor likely to command attention will do the work, I feel that it is better that a private individual should incur ridicule or censure than that no attempt should be made in the way of change. I must beg to remind the reader who may be thinking that "fools rush in where angels dare not tread," that it does not follow that because a man's life is spent in the pursuit of science in the laboratory, therefore he is the fittest manipulator of theory or of language. It is not certain that because a man makes a tool or a compound, he shall therefore know how to use it. Neither is it written—from him that hath not the opportunity of experiment shall be taken away the privilege of thought.

We have at present, it is true, a chemical nomenclature, which once was, as Lavoisier evolved it, a system. It is now no longer a system, but a fashion full of confusion; our science has outgrown in the last half-century the vestures of its youth. I have not proposed mere new names, but an orderly method or system of name-making, under which each compound would receive an appellation according to its composition and its che-



PART I.

OF SALTS GENERALLY.



the anode. To compounds of this structur term Salt has been applied as a class name; there has been a very evident tendency in writings of chemists to obscure the distinc that separate Salts from other chemical c pounds. The habit of generalizing would al put before them a temptation to consider all c pound bodies as belonging to the same type. Salt, which is the simplest kind of compo happened to be the first of which the nature distinctly ascertained; so chemists have been apt to suppose that all, or nearly all, compo must belong to this bipolar, two-membered tem. Now it is quite certain that there are o forms of construction besides that of the S there are many compounds which consist of t members, others of four, and of higher numl In these compounds other forces of attachn must be concerned, which are distinct from, not obviously related to, the voltaic force; haps even amongst truly bipolar compounds t arc many whose two members are held toge by a power different from that which is neut ized in voltalysis. We are at present igno of the modes of excitation and of propagatio these other forces; we shall probably one day cover, generate, conduct, and manage them. cannot yet quite satisfactorily classify such c pounds as owe their coherence to these ot modes of chemical attachment, though we mi indicate several groups of them.

2. But with Salts the case is different: we have so much information about the mode of construction of these compounds, we have among them some types so marked and distinct, that though we may not be able at once to bring together all bodies that truly belong to this class, and to arrange them therein, while we exclude decisively all that are properly of other kinds, we may clear our notions about them very considerably, and may set up a standard around which we may group them by degrees, and may indicate certain other species which have no claim to be put among them. Perhaps we may also at the same time observe other well-marked forms of constitution, to which some of the non-saline compounds may be referred. Salts easily classified; may afford standard of classification.

3. The study therefore of the constitution of Salts should be extremely useful to the student, and one on which he may enter with a lively interest; but to this, as to all other studies, one necessary preliminary is a clear understanding of the meaning of the terms employed. It is highly desirable, when this is possible, to fix, by formal definitions, the sense in which standard terms are employed. When an exact definition is not attainable for any particular term, on account of the imperfection of our knowledge, its general scope of meaning should be clearly indicated, and the obscurity which attends its application should be stated: this plan I shall follow through this book. We have then to settle the senses of the terms "Constitution" and "Salt." Definitions.

'Constitution' implies arrangement of components.

4. First then let us consider what we are t
derstand by the word "Constitution."

5. We find that, besides the composition
substance as to its elements, and its more p
nent combining tendencies as towards othe
dies, some other quality is necessary to the i
fication, in our minds, of a chemical species
we find that two bodies may have the same
position as respects substantive elements and
quantity, and that they may even have the
general combining habits or functions, an
may be quite different species. This differen
isomeric compounds, as we term them, may b
dicated by a difference in physical character
in some of the less obtrusive of their che
tendencies. For this difference we must acc
to ourselves, and we can only do so by supp
that it is connected in some way with the
in which the components are arranged within
compound, with respect to each other. If
be any arrangement of the components, or, a
may say, of their molecules or atoms, it mu
of the highest importance in determining the
ferent properties of bodies that have the
composition; and if it be important in these
which have suggested it to us, it must be eq
essential to all other bodies whose composi
does not happen to present itself under more
one form; for we cannot suppose that in s
bodies the component molecules are arranged,
that in others they are confused. This no

then of the arrangement of the component atoms within each molecule of a compound, we express by the term "Constitution."

Indefinable as yet.

6. Yet we cannot define the meaning of this word; it represents to our minds, in some form or other, which must be more or less hypothetical, a fact, which is certainly essential to the substances which we examine. But we cannot ascertain precisely what this fact is, because hitherto we have found no means of bringing it to bear directly upon any of our senses. We cannot realize conclusively to our mental vision the manner in which an elementary atom enters into the system of a solid compound, still less can one person imagine, in a manner that shall satisfy every other mind, the mode in which one complex molecule is bound to another within every mobile particle of a liquid or fluid substance. It is not easy to dissociate our conceptions of the fact from some form or other of geometrical configuration, yet it is equally difficult to believe that such forms as those we contemplate in crystals are concerned in the coherence of these invisible particles. As science advances we shall probably get a clearer insight into the essence of this "constitution."

Hints as to its nature, from composition and decomposition.

7. At present we have only certain hints concerning it. These we derive from the modes of composition and of decomposition, which we observe to belong to our substances. When we find that in the decomposition of a body a certain element or undecomposable substance is obtained, we

suppose that, in some sense or other, such ele existed in the compound before it was destro and when we unite one element with another, produce a third substance, we conclude tha some form or other, the two elements are no the compound. We may apply the same no very logically, to the cases in which, not elem but substances themselves decomposable, are parated from or enter into the formation of c compounds; so we may say that compound m cules exist within or form part of the matte other more complex particles. This may not the true notion of the constitution of compou but if we bear in mind that it is not stated a fact itself, but as an expression of other facts h ing the closest connection with the "constitutio which we are seeking, it may be very convenien used as a vehicle of thought.

ormulæ; ow they present onstitution.

8. It is thus that we represent the constitut of compounds by formulæ. By an "empiric formula we denote in symbols the quantitat composition of a substance; so by a "rationa or, as it might be called, anatomical formula, express a mode of composition or decomposition a substance. It is altogether an error to suppo as has been stated, that a chemist, in using fo mulæ in which he disposes the symbols of t elementary components of a body in groups, making a geometrical picture of its mechanic structure. He may not be able quite to separat in his mind, the notion of relative position fro

that of relative function in composition or decomposition; yet it is certainly only the latter condition which he means to assert, or has any right to assert, by his arrangement of symbols. It is in this sense only that I wish the formulæ which I shall use in these pages to be understood.

Three theories as to mere complex bodies.

9. In the cases of very simple compounds there can be generally little doubt as to the mode in which their anatomy shall be represented. But for substances of higher complexity this may be a matter of doubt. Such bodies may be formed or decomposed in several ways, being generated by, or yielding as their products either one set of molecules or another. In either case there are only these alternatives of explanation: 1st, either such compound has no constitution, but is characteristically composed of a "concourse of atoms," regulated only as respects their number; 2ndly, or it has a constantly varying constitution, that is to say, its component atoms are in a state of constant spontaneous motion or interchange of place, so that at one moment the body will tend to decompose in one manner, at another moment in another; 3rdly, each has one standard mode of internal arrangement, which is always assumed by its components when they form this particular compound, though it is liable to be disturbed by the action of forces from without upon the substance, the properties of the compound being the outward and visible sign of this arrangement.

its:' mon salt type.

13. We have next to determine the sense which we are to use the term "Salt." This nam is given in common parlance, according to tim honoured sanctions of the leading languages the world, to a certain body (Na:Cl). Since th is one of the most widely known and most unive sally used of substances, and is also formed on th simplest possible of chemical composition, consis ing of two members, it is well fitted to become classical term of more general application; accord ingly it has been used, in modern chemical lan guage, by universal consent, to denote all the bo dies of composition analogous to the Common Salt Perhaps however we do not always remember quit distinctly what constitutes real analogy to ou Chloride of Sodium, so that the term "Salt" ha been bestowed sometimes upon bodies which ar not made upon the model of this compound; i is important then that we first state what is th essential point of such similarity.

mon salt ltalyte.

14. The most vital condition of the existence o Common Salt is that it is a Voltalyte, or that it is decomposable by the voltaic force into two mem bers, one of which tends to go towards one termi nal of the conductor, the other towards the other one of which therefore may be called positive, the other negative. In Common Salt each of the two constituent elements are supposed to be present in the smallest proportion in which it enters into composition; one of these, the Chlorine, is said to be voltaically or chemically negative; the other the Sodium, positive.

15. This same character of the polarity of the constituents belongs to all those compounds which most resemble this Salt in general properties and in composition. There are however many bodies which are strictly analogous to it in chemical behaviour, but which differ from it most widely in composition, as consisting of several elements, and of some of these in quantity greater than that of their least combining proportion; but every such substance either certainly does, or if appropriately treated in all probability would, split up under the voltaic current into two primary members, either or both of which may consist of two or more different elements, and of several proportionals of some of these. Such are

Compounds voltalytic into two members—Salts.

"Chloride of Ammonium" ($H_3,N;H:Cl$)
and "Sulphate of Sodium" ($Na:O;SO_3$).

In some cases the body seems to resist voltaic decomposition, but indicates, by the interchange which its members make with molecules of known voltaic polarity, that it is constructed on the same plan with true voltalytes, and that its members are, in the same sense, polar to each other: such a compound is Chloride of Ethyl ($C_4H_5:Cl$). All these may be comprehended within the general term "Salts."

16. On the other hand, there are other compounds which resemble Na:Cl in consisting of two atoms which are in some sense polar to each other, but which are not, so far as we know or have reason to believe, united by the voltaic attachment.

point; but in the organism of Salts of compli
structure there are other subdivisions whic
quite as important to be noted as any which
been thus designated. A chemical termin
which stops here is as imperfect as a lan
would be, which, having been contented with
for the head and trunk of an animal body,
plied no terms for the features or for the li
We must then extend the application of this
ciple; we must have names for the different
of a Salt,—names which, when applied to
given molecules of such a compound, shall
cate the chemical position which they occupy
system: and we may without confusion us
same words to express generally, on the one
the constituents of Salts when in compositio
actually filling certain functions or positions;
on the other, to denote such substances, whe
can separate them, as have a potential tenden
assume such positions. The nomenclature of
mistry is, in several points, extremely deficie
precision; our knowledge has in fact outrun
vocabulary, and is now very much in advance
This will not be denied by the most steadfas
herent to antiquated forms.

'hemical omencla- ure very nprecise.

23. A prominent instance of this obscu
which it is of prime importance to our pr
purpose that we should avoid, is afforded by
terms "Acid" and "Base." These words
constantly occurring in discussions concer
Salts; but their meaning, and the relation to

'ndeavour) define cid' and ase.'

of the kinds of substances which they repre-
left in darkness by the current phraseo-
of chemistry, though there lurks in them, re-
, a constant reference to the two opposite
of saline compounds. Although adepts may
know what is meant by these two words,
used in such a manner as to involve the
of the novice in considerable perplexity. Let
us endeavour to find their value; and if it does
appear that any fixed meaning has yet been
to them, then let us, if not give, at least
them such, for the purposes of this book.

Confused use of 'acid.'

First, of the term "Acid." Two distinct
of compounds are usually included under
term,—classes so utterly distinct in function
the comprehension of them under any term
porting to be generic, is quite contrary to or-
method; indeed I scarcely see how any term
universal than the wide word "compounds"
be applied to them. Of one of these two
es, "Hydrochloric" (H.Cl), ordinary "Sul-
" (H:O;S,O_3), and "Oxalic" (H:O;C_2O_3)
ids" are instances, each being the type of a
ct order within this class. Of the other
o-called "anhydrous" "Sulfuric" (S,O_3O),
f-Arsenic" (As,S_4), and "Fluo-Silicic" (Si F_3)
are examples, each from a peculiar group.
compound of the former class contains Hy-
n, basic Hydrogen as it is sometimes called,
, when the Acid forms a metallic Salt by che-
combination, is displaced from its composi-

tion, while a metal enters in its stead. No c
pound of the second class contains any such I
drogen, but each enters into the construction
metallic Salts, by union, without loss of any
of its constituents, with a pre-existing meta
compound, such as an oxide, sulfide, or fluoride.

25. Now, Acids are usually said to combine w
Bases, to form Salts; but it will be observed t
no compound included under the first of th
classes (having a part of itself, its Hydrogen dri
out and replaced by a metal, in the formation
metallic Salts) can be said ever to combine, in t
process, with a Base, whether we call a metal
the oxide thereof by this name; for all the mo
cules of the original "Acid" no longer exist in t
new compound; the "Acid" therefore has r
entered into combination at all. Compounds
the second class however may be said to combi
with Bases, if we limit the application of the te
"Base" to the compounds formed of certain m
tals, with certain non-metallic bodies, for instan
with Oxygen, Sulfur, and Fluorine. But with t
signification of the term it is more impossible th
ever to say that an "Acid" of the first class co
bines with a Base; for not only does not the Ac
exist in the resulting Salt, but neither is the Ba
to be found in it.

Confused use of 'base.'

26. There is thus also a confusion in the use
the term Base. Three distinct classes of subjec
are called by this name. Sometimes Hydrogen i
self, and such metals, or complex molecules, as t

combining with Oxygen, Chlorine, etc., form true Salts, are called Bases. For example, Potassium (K) and "Ammonium" (H_4N). Sometimes the oxides of such bodies, f.e. Potassa (KO) and Ammonia ($H_4N;O$), are so named. And sometimes a class of bodies which by combining with Hydrogen already in composition, fill a place in a Salt analogous to that occupied by a metal of the first class, f.e. Ammonine (H_3N).* One author gives the name "Base" to one of these classes; another to another; another to two of them; another to all three indiscriminately.

Confusion between 'base' and 'alkali.'

27. Further, the terms Base and Alkali are used sometimes interchangeably, sometimes distinctively, in inextricable confusion; but it is really necessary to call different things by different names, and not to torture one word into several different services. Let us try then to avoid the one and to do the other.

Definition of 'molecule.'

28. First, let me here state that I shall always

* Here, first, for the sake of distinctness and uniformity, I must take leave to depart provisionally from the usual nomenclature. For analogy to Aniline ($C_{12}H_7N$), which in chemical habit corresponds exactly to the gas commonly called Ammonia (H_3N), I shall for the present call the latter substance Ammonine; and for analogy to Potassa (see § 58, p. 46), which the compound of Ammonine with water ($H_3N;H:O$, often also called Ammonia) closely imitates, I shall reserve the term Ammonia for this last compound. By the term Ammonium I shall of course mean as usual (so long as I use it) that part of Ammonia which corresponds to Potassium, viz. $H_3N;H$; not however as allowing that these molecules have any claim to be considered a compound metal.

use the word "molecule" as meaning any ch
atom or definite group of atoms, and shall r
'body,' the term "body" to a molecule which is kn
exist sometimes in the isolated state; by the
'substance,' "substance" I shall denote a separated bod
'atom,' the expression "atom" I understand the sm
proportional quantity in which an element
into composition,—I take it in the sense in
the word "equivalent" is commonly used; b
'compound,' substantive "compound" I shall always m
(*b*) body which is composed of more than one ele
'complex,' by the adjective "complex" attached to a
cule, I shall mean that it is composed of more
'compound,' one elementary atom; by the adjective "
(*a*) pound" I shall indicate that particular case of
plexity in which the complex molecule is isol
'attach- a body; by the term "attachment" I shall
ment,' the force of or tendency to chemical union,
erted or evinced by elements or compounds.
affection is of different kinds, which I shall d
guish by appropriate epithets. This is us
contrary to all analogy and to the usage
'affinity.' other naturalists, called "affinity" by che
"Affinity" distinctly means family relation
the nearer this connection, the less, general
the chemical attachment. I shall always us
word affinity to mean that relation of speci
species, or of genus to genus, which is indi
by similarity of properties.

Notion of 'base.' 29. Now the word "Base" recalls the noti
something simple and fundamental, on which s

thing else is built up. Thus a chemical element on which a Salt may be constructed may be called a Base, more especially if it be one of those metals which help to form the foundation or basis of our earth-crust: just such an element is Potassium, the very type of one of the classes of substances which have been called Bases by some chemists. Let us then agree to assign the term Base to Potassium, and to all such molecules as occupy in the structure of Salts a position identical with that taken by this metal; that is to say, to such as are or may become the volta-positive members of Salts. Now a Salt of the simplest kind is erected upon such a Base by uniting with it any of the following substances: Fluorine, Oxygen, Phosphorus, Sulfur, Selenium, Tellurium, Iodine, Bromine, Chlorine. Let us apply to this group of elements as a class-term the name Halogens.* We also may provisionally include Cyanogen, which so much resembles these elements in its department, under the term Halogens, when we are using that word in a sense referring not to classification, but to function. From this fundamental fact then we can deduce the following definition:—

30. "A Base is a molecule which by combination with a Halogen forms a Salt." Definition of base.

31. Beside our class of Halogens there are other compound molecules, which occupy in Salts the same position which is filled by these simple bodies. We must have a general expression which shall in- 'Base' implies a 'style.'

* See note, p. 39.

clude such molecules as well as the Halogens; shall then have a term for the second or negat member of a Salt, co-ordinate to that which have already assigned to the other member. N it is curious that no such term is to be found chemical literature; there is no word to expr this cardinal idea in the theory of Salts; the o word which is ever applied exactly in this sens "radical;" but this word is, professedly, used a far more general acceptation, namely as me ing any molecule which seems to take the pl of any element—not a Halogen only—in compo tion, and actually it is also bestowed upon mo cules which have no such claim to distinctio thus both Cyanogen (C_2N), which takes the pl of Halogens, and Ethyl (C_4H_5), which is a b are called radicals. The adoption of this w would probably involve some confusion, and it not any advantages in aptness, brevity, or euph which need tempt us to take it restrictedly i this special service: we must then find a new te for the purpose. Now the word Base, which have taken for the one member of a Salt, is, by original signification of the lower part of a colu nar structure, peculiarly suggestive of an archit tural term. The *βάσις* of a column suggests *στύλος*, or shaft; from this Greek word we m take its English form "Style" as an appropri antithet to our word "Base." In another sen too the two words are aptly opposite: while t

* See note, p. 72.

Base of any object is, for stability, broad and flat, the word "Style" has for one of its meanings that of a sharp-pointed pin. We may also connect these notions in our mind with the deep or grave taste which is characteristic of compounds in which the basic character predominates, as of Alkalies, and with the acute or sharp savours which belong to compounds in which the opposite affection is strongest, as to certain Acids. We may then take this term, which as a neat monosyllable will be found very useful in compounding terms, and may define it thus:—

32. *Definition* 4. A "Style" is a molecule which by combination with a "Base" forms a Salt. Definition of 'style.'

33. Both Bases and Styles then, or in any Salt both or either of these members, may either consist of a single elementary atom, or may be compounded of several. Let us call those of the former kind simple, those of the latter complex;* and Expressions of degrees of complexity.

* It is important to keep in mind the distinction between the expressions "a double or multiple Salt" and "a complex Salt" on the one hand, and on the other between "a single Salt" and "a simple Salt." Let it be remembered that I use the term "single" as antithet to "double" and "multiple;" "simple" as the opposite to complex. The ideas are radically different, but admit of being compounded. Thus we may have the following cases, as here exemplified:—

1. A single simple Salt, *e.g.* Na:Cl.
2. A single complex Salt, *e.g.* $H_3,N;H:Cl$.
   and $Na,O:S,O_3$.
3. A single bi-complex Salt, *e.g.* $H_3,N;H:O;SO_3$.
4. A double simple Salt, *e.g.* $\frac{H}{Ag}\Big|\frac{I}{I}$

since single words are often very convenient as stitutes for phrases, let us take the words "H base" and "Haplostyle" (ἁπλόος, simple) as nyms for the terms simple Base and simple S respectively, and "Plectobase" and "Plectost (πλεκτός, complex) for complex Base and com Style; the more general terms "Haplopole" "Plectopole" will include respectively and sever the two pairs of analogous molecules. Again, us apply to all such Salts as have both a sim Base and a simple Style the term Simple Salt "Haplohale" (ἅλς, salt); to such as have ei the Base or the Style complex the term Comp Salt, or "Plectohale," and to any such as has bo members complex the term Bi-complex Salt, "Diplectohale."

Combinations of these expressions.

34. Now our two terms, Base and Style, which we will designate the two members of Single Salt, supply us by verbal composition wi

5. A multiple complex Salt, *e. g.* $\begin{array}{r|l} K & O;S,O_2 \\ \hline Fe & O;S,O_2 \\ \hline (H & O)_6 \end{array}$

6. and $\begin{array}{r|l} H_3,N;H & Cl. \\ \hline (Ni & Cl)_2 \\ \hline (H & O)_{12} \end{array}$

7. A multiple bi-complex Salt, $\begin{array}{r|l} H_3,N;H & O;S,O_2 \\ \hline Ni & O;S,O_2 \\ \hline (H & O)_6 \end{array}$

The reader accustomed to the ordinary formulæ will have no d ficulty in understanding these examples. I shall hereafter expl the system of punctuation which I have here introduced: to so here would be to anticipate unduly some future steps in c examination of Salts. See note to § 45, p. 32, and § 64, p. 54

two most convenient synonyms for such a Salt. We may most naturally denote a compound which consists of a Base united with a Style by the terms "Basi-style" or "Stylo-base." I shall then use these terms as the equivalents of the word Salt, applying the one or the other of them according as I wish to refer primarily to the "Style" or to the "Base" of the compound: I shall use the term "Stylo-basic" as a distinctive epithet for the attachment which unites the "Style" and "Base" of a Salt. Again, we may designate any Salt having a simple Base, a simple Style, a complex Base, or a complex Style, by the terms "Haplobasistyle," "Haplostylobase," "Plectobasistyle," or "Plectostylobase," respectively.

Bases and Styles polar to each other —Halopoles.

35. Generally, then, our Bases and Styles are, respectively, the two opposite members in Salts; the Style being the volta-negative and Base the volta-positive part. And such molecules as have the tendency to assume one position or the other may be called Styles or Bases respectively; and since, in Salts, these members are opposite and correlative to each other, they may be called the poles of the Salts, or abstractedly "Halopoles," and relatively to each other "Sympoles."

Position of Halopoles may be doubtful.

36. So we may take for our *Definition* 5:—The "Halopoles," or poles of a Salt, are its Base and its Style. In the case of Single Simple Salts, there can never be any doubt as to where the division between the two Halopoles lies, because each consists of a single elementary atom which is entirely

Stylic or entirely Basic; but as to Complex Si there may be sometimes a doubt as to the side the system to which a given atom may belo One of the chief objects of our inquiry in th pages will be to observe the general laws of distribution of the atoms in Complex Salts; i in this inquiry the neutral point of separation tween the negative and positive members is m important to be noted, and must not be shifted fr its true position in our notions and representatic of Salts.

Diagrams of constitution.

37. As by formulæ we represent the compositi and constitution of compounds, so for the purp of grouping our conceptions we may represent t various kinds of compounds by symbols of a s more general signification; we may represent th by diagrams composed of lines, provided that remember that the figures which we adopt do r indicate geometrical forms, but chemical relatio Thus a Simple Single Salt, as a bipolar syste may be appropriately denoted by a right li marked with a small cross-stroke to denote t division or connection between its Base and Style, thus —+—. The same symbol may be us provisionally for any Single Salt, when complexi is not predicated of either its Base or its Styl we shall have frequent occasion hereafter to resc to this symbol, to illustrate, with the aid of sor others, the constitution of various kinds of Salts

"Acids"—primarily

38. We are now in a condition to seek a cle meaning for the word "Acid," a term with whi

we can by no means dispense. In appropriating to a single sense a term which has been loosely applied to several, we must be careful to select that signification which has the best right to it, being guided in our choice by considerations of etymology, of most familiar use, and of original application. Now the name "acid," meaning by derivation "sharp," was undoubtedly first bestowed upon certain substances exerting on our taste-organs that peculiar effect of sourness which we by instinctive analogy call "sharp." Vinegar, or the acid of soured wine, was the first and best known of these substances in former days. By gradual advance we have become acquainted with others, which resemble vinegar more or less in taste and in certain chemical properties, f. e. in those of reddening litmus-blue, and of helping to form Salts, under similar conditions, with Bases. Among these are the compounds which used to be known by the names "Spirit of Salt" and "Oil of Vitriol" (to wit, H:Cl, and $H:O;S,O_3$). We have come to know in modern days that these latter bodies are similar in an important point of composition to Vinegar; and before this we had already become accustomed to call them, respectively, Muriatic Acid and Sulphuric Acid. Beyond a doubt these bodies, along with Vinegar, or Acetic Acid as we call it now, are entitled to the first place under the head of "Acids," as soon as that term is extended to a distinct generic or classical signification: let us then admit them.

sharp, reddening litmus blue.

Contain Hydrogen, exchangeable for base in salt.

39. Now the point which these substances have in common, in regard to their composition, is that they all contain Hydrogen, in such condition that when a metallic Salt is formed by the treatment of them with a Basic metal, the metal enters the compound and seems to occupy the place held by the Hydrogen in the Acid, for the Hydrogen has disappeared, the rest of the original compound remaining the same; and this quality we have found, as our knowledge has advanced, to be common also to many other substances; some of which have the acid taste, and the faculty of reddening Litmus-blue, such as the Bromide of Hydrogen (H:Br.), while others of them have not, f. e. the Telluride of Hydrogen (H:Te). But all of these bodies, by the close similarity of their deportment in the important business of Salt-making, claim to be considered as co-classicals with the old Acids: we are warranted then in admitting these also under the term Acid, thus extended for their accommodation. And this condition of chemical composition and chemical habit is one of primary significance in the formation of Salts. We may therefore limit the application of the term Acid so as to exclude all bodies which are not thus endowed. But even a closer limitation of usage may be desirable; for there are among the bodies of this class, which are commonly called Acids, some which bear this additional resemblance to Vinegar and to the typical acids just mentioned, that they are soluble in water: others there are which,

though they have the same chemical function with these as respects salt-making, differ from them in being insoluble in that liquid. Now solubility in water is a most important point in the physiology of a compound, leading, as it does in many cases, to the use of the body which enjoys it as a solvent or precipitant in chemical processes. It may be well then to found a nominal distinction on this difference, although there is here, of course, no absolute demarcation.

May be termed Salts, having Hydrogen for base,

40. Now a Salt consists of a Base, together with a Style. But a Salt is also formed from an Acid, by the expulsion of Hydrogen, and by the substitution of a Base for that element. We may therefore say that Acids are Salts, having Hydrogen for their base, or that they consist of Hydrogen, combined with a Style; hence we may conveniently call them Hydrostyles; and the same character applies to numerous bodies which are analogous in chemical function to Vinegar, but which are insoluble in water, as well as to such as, like that acid, are soluble. We may therefore define this term thus:—

or "Hydrostyles" (Hydrogen with style).

41. *Definition* 6. A Hydrostyle is a Salt consisting of Hydrogen combined with a Style.

Hydrostyles soluble in water,—Acids.

42. Such Hydrostyles as are soluble in water I would call, by way of preference, Acids, and to such only I shall, in these pages, apply this name. I cannot however insist on this restriction of the term Acid, as it may fairly be claimed, by those who would give it a more general signification, as

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acids are remarkab
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on this account agair

Stylic and basic members of Salts, their laws of complexity.

13. We have now
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a Base, a Style, and a
ting these terms and
we have left certain su
ters without generic na
we shall come to these
arrive at a mode of na
with our analysis of Sal
range our discussion un
shall treat of the stylic
Salts separately. We
because less change has
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these molecules charac
ledge of the Bases. whi
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question then that we have to consider, concerning the constitution of Salts, is, What are the laws, if any, of the complexity of these members?

44. We will presently enter on the consideration of the complex Styles.

The Binary and Unitary theories: Davy and Gerhardt.

45. Here the reader should be reminded that the view of the constitution of Acids and Salts, which I am now advocating, was in its generalities thus far first proposed by Sir Humphry Davy. It did not find favour with his contemporaries. It has been revived and supported of latter years by several chemists, under, as I have said, much confusion in nomenclature; and some of these authorities have, without warrant in nature, extended its bipolar theory of the organization of Acids and Salts to substances of a character totally different from theirs. But objections have been urged against its adoption by other writers. The chief of these counter-arguments is, that this Binary Theory requires, it is said, the supposition of the existence of certain bodies, which we do not know in the isolated state, and which, having baffled all efforts to produce them, probably do not exist: such hypothetical compounds are the complex Styles, which form one member of all such salts as the Carbonates, Sulfates, etc. ($B{:}O;C,O_2$,— $B{:}O;S,O_3$, etc.*). In answer to this objection, I

* I shall use the symbols B and St (which are not appropriated to any elements) to represent respectively, in the general formulæ of Salts, the Base and Style, either of which may be elementary or complex. In all salt-formulæ representing the con-

can only say, that, far from admitting that this theory demands, in the least degree, the existence of these bodies ($O;C,O_2$,—$O;S,O_3$, etc., or CO_2—SO_3, etc., as the objectors would write them), I consider that the non-existence of these Styles as isolable bodies confers a most remarkable beauty on the system of the Salts as I understand them. Another kind of objection has been raised of late years to this view of the constitution of Salts, in the shape of an antagonist theory; this is the so-called "Unitary" Theory of M. Gerhardt. He

stitution of Salts, I shall place a colon (:) between the parts that symbolize the two Halopoles; all the letters that lie on the left side of this stop (the two points of which are suggestive of bipolarity) will represent the elements that together make up the volta-positive side, all that part of the formula on the right of it will represent the negative member of the Salt, so that this stop may be taken as a symbol of the stylobasic attachment. In general formulæ I shall use Mb to represent one atom of any Metallic Base, and Ha for one atom of any elementary style or Halogen; thus, B:Cl will mean any Chloride salt, K:St any salt of Potassium, H:St any Hydrostyle, and Mb:Ha any salt of a Halogen with a basic metal. I shall use other marks, such as the semicolon, comma, and full stop in the punctuation of my formulæ, to indicate other kinds of attachment, not stylo-basic, between the elements on either side of them. These other stops will not represent inferior degrees of attachment as respects energy, but, in Salts, will mark inferiority of position as respects importance in the entire compound attributed to those molecules that lie outside of the secondary points, away from the central colon (see § 109, p. 88, and § 94, p. 75). Thus in the formula for "Sulfate of Ammonia" $=H_3,N;H:O;S,O_3$, H and O are the two principal members of the bipolar compound, the groups H_3,N and S,O_3 are adjuncts, which adhere as secondary members to the original two; such adjuncts may or may not be united by a pow-

endeavours to show that a great number of Salts, and various bodies which are not salts, are included under the general idea of a tripolar compound, the simplest form of which is supposed to be water, which is represented as $\left.\begin{matrix}H\\H\end{matrix}\right\}O$, that is to say, as consisting of two volumes of Hydrogen with one of Oxygen. Whatever may be the truth of this theory in certain cases, I shall endeavour to show hereafter that it is demonstrably false as applied to a large number of true Salts, the real nature of which it, as seems to me, entirely misrepresents. It is somewhat curious that we should find the Binary Theory maintaining the unity of the Hydrogen of Water, and opposed by the so-called "Unitary," which holds that Hydrogen is

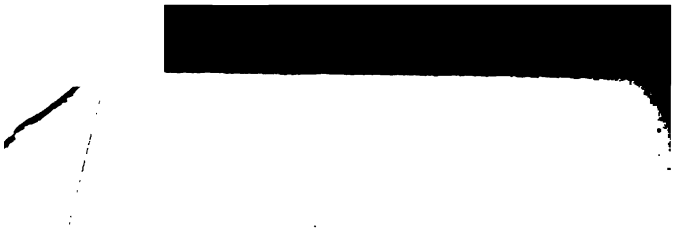
erful force to their primaries: of these adjuncts more hereafter. By thus using the points in our formulæ as actual symbols of definite ideas, we shall give to them an expressiveness which they cannot otherwise attain. I may here add, that I shall always put the index numbers, which in the formulæ of compounds denote the quantity of molecules of an element or of a complex group that occurs in the compounds, to the reader's right of the elementary symbols to which they refer, and slightly below the line of type; I shall enclose these letters between brackets when a complex molecule is so numbered, the index figure belonging to the whole group within the brackets at the right of which it stands. When the index figure is placed before a group, it will import that a certain proportional quantity of the substance symbolized is spoken of as a free body, not as part of a compound. Thus in S_2O_3 there are three molecules of Oxygen, in $K:O;(SO_3)_2$ there are two molecules of S_2O_3, but $2(SO_3)$ will denote that two proportionals of SO_3 are separated.

binary, Water being taken as the prototype* of pound by the advocates of each: such are vagaries of language.

* By the term *prototype* I mean to designate the sim form of any kind of structure, in which the plan of such struc may be seen as it were first sketched.

PART II.

OF STYLES.



CHAPTER I.

OF THE DIFFERENT KINDS OF STYLES.

"Complex" and "Compound" Bases and Styles.

46. It will be observed that I have spoken of "complex" Salts, and have called such Bases and Styles, as contain more than one elementary molecule, "complex," and not "compound." I do not apply to all of these generally the epithet "compound," because that word would imply that all these Bases or Styles actually exist as distinct compounds, as isolable bodies. "Complex" is a more general term, which only predicates that they are not simple or elementary. The term "a compound body," it will be remembered, is to indicate a particular case or kind of a complex group of molecules, namely, a complex group that can be isolated, so as to enjoy a separate existence. Compound Styles and Bases do exist: Cyanogen (N,C_2) is such a Style, distinctly akin in function to Oxygen and to Chlorine, and existing as a separate compound, and from this resemblance it may be called a compound Halogen; Methyl (C_2H_3) is such a base, being an isolable body, analogous

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therefore reason for, this d
have to explain in the seque
Stylic molecules which do n
salts, but require multiple
ments; I propose to consi
as we meet them, confining
main to the Styles and Base
speaking then of Bases and
rally, unless the contrary is e
fer to such as occur in Single
shall usually designate by the

Hydrostyles most convenient for classification.

47. But we cannot fairly dis
Styles of Salts according to
and treat them separately, witl
Stylobases which they form; t
est number of them are not k
free state. We must then co
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actual Base, with which the
combi...

general vehicle of all Styles for bringing them into union with other Bases. Standing too by itself as the only Base among the class of "Zoogens,"* it is peculiarly adapted for this special service. In classifying the Salts according to their Styles, or, more conveniently, the Hydrostyles, we shall be practically classifying the Styles themselves.

Grouping of Hydrostyles.

48. Our term Hydrostyle, as limited by our definition, is sufficiently comprehensive, notwithstanding its exclusion of a great number of bodies hitherto called with them by the common term of Acids. The class of Hydrostyles, as thus ascertained, may be conveniently divided, for the purpose of examination, into groups corresponding to certain groups into which the Salts may be divided, according to the constitutional characters of the negative or Stylic members of the several species.

Three groups.

49. These groups are three:—

1st, With Styles, known separate.

50. 1st, Hydrostyles, whose Styles being simple or complex, are known separate from any Base as single existent bodies.

* Here I must explain, that by the term "Zoogens" I mean the three elements Hydrogen, Nitrogen, Carbon, which I take to constitute one of the three main classes of the kingdom of elements; the nine Halogens, as before defined (see § 29, p. 21), constituting a second class; the third consists of all the other elements, under the title of Metals, or "Geogens." I take the word "Zoogens" to denote the chief function of H, N, and C, in building up all organisms that have life (ζωή); by the word "Geogen" I would indicate that it is to the metals that the solidity of the earth (γῆ) is due. The Halogens are those elements which form Salts (ἅλες) with the basic Geogens.

[redacted]

[redacted]

31. 2nd. Hydroxyles, whose Styles being com plex, are not known separate from a Base as sing bodies, nor may be divided into definite submem bers, one of which is by itself a Style, and each which may exist separately, while by joint reunio with a Base they will together again form a Sa containing the original Style.

32. 3rd. Hydroxyles, whose Styles being com plex, are neither themselves known separate fro a Base, nor can be divided into such submembe as that one of them being by itself a Style, the by joint reunion with a Base, will again produce Salt containing the original Style.

33. To the first of these groups belong, course, all those Acids whose Styles are elements such as Muriatic or Hydrochloric Acid (H:Cl and Sulfuretted Hydrogen, or Hydrosulfuric Aci H:S, and also such bodies as Hydrocyanic Aci H:N.C_2 or H:Cy, in which the complex Halo gen, in this instance Cyanogen (N,C_2 or Cy), re sembles an element in its ordinary behaviour.

34. To the second group belong the Hydro styles, called Sulfuric (H:O;S,O_3), true Carboni H:O;C,O_2, Nitric (H:O;N,O_3), true Silici (H:O;Si,O_3), true Sulf-Arsenic (H:S;As,S_5), Fluo Boric (H:F;Bo,F_3), Ferro-Cyanic (H_2:Cy_2;Fe,Cy) Acids, and a host of others. Of none of these is the Stylic member known as a separate body; but that part of each of these examples, which is indicated in the formulæ by the symbols on the right hand of the semicolon, is known as an isolable com-

nd. It will be observed that the rest of the lic member in each case consists of an elemen- y body, or of one which resembles an element its behaviour. Thus the two submembers into ich the stylic member of each of these complex drostyles separates itself, when released from its se, are divided from each other in the formulæ a semicolon. We must return presently to the sideration of this order of Hydrostyles, the lysis of which is of prime importance to our rpose.

55. To the third group are to be referred a vast mber of bodies which are formed almost solely the processes of Zoogenic chemistry, such as following acids: Oxalic ($H:O;C_2,O_3$), Formic $:O;C_2H,O_3$), and infinitely many others. Of ne of these is the stylic member yet known in separate state; nor are any two bodies known ich, being put together and united with a Base, l constitute a Salt of these, having the Style of of these Hydrostyles. The semicolon there- e, in the formulæ for these acids, does not di- e the Stylic member into two submembers, ich may be separated and reunited in presence a Base, or otherwise: this stop is placed in the mulæ to indicate an analogy in the apparent struction of the substance to that of the Acids the second order. In Hydrostyles of this order ither the Stylic member nor the submembers of s part, but only the Hydrostyle itself and its ivative salts, are known as isolated compounds;

Examples of 3rd class.

these bodies are obviously built upon the sa
plan as are those of the second class, but the for
concerned in the formation of the styles are p
bably in some cases different. Several of our l
drostyles have recently been transferred by t
discoveries of M. Gerhardt from this third or
to the second, but there are still many of whi
the construction is so delicate, that hitherto we
unable, by our coarse methods, to resolve th
into their proximate constituents. If we distu
their equilibrium, they fall to pieces under c
hands, and with all our devices and all our skill
cannot put them together again.

Correspond-ing Style,—groups.

56. Let us now briefly consider, in turn, t
three groups of Styles or of Basistyles correspo
ing thereto, as to their constitution and as to th
nomenclature, general, special, and anatomical.

CHAPTER II.

OF STYLES OF THE FIRST GROUP.

SECTION I.

Of Single Salts having Styles of the First Group.

Styles of First Group, —elementary Halogens, Cyanogen, and Mellone.

57. Nothing remains to be said respecting the constitution of Salts having styles belonging to the first group, except to remind the reader that in all true Salts there is only a single molecule of style for each molecule of actual base, so that the stylic members of the single Halogen salts of this group are always single atoms of Halogens. These styles we have defined thus:* "Such as being simple or complex are known separate from any base as single existent bodies." The only Styles which we here find, besides the nine elementary Halogens, are the compound Halogen Cyanogen ($C_2N=Cy$), and perhaps its still more curious but doubtful analogue Mellone ($C_6N_4=Me$); according to Liebig, this latter stylic molecule exists in the free condition and combines with Bases forming Salts of the form B:Me. Its hydrostyle (H:Me) is a strong acid,

* See § 50, p. 39.

though less soluble in water than most of the oth hydrostyles of this order; it also differs from the in being under ordinary conditions a solid sul stance, while all the others of this order are eith gases or easily volatile liquids.* We may provisio ally include this compound with Cyanogen and t elementary Halogens under the term "Autostyles as being bodies which of themselves (*αὐτός, sel* have stylic power. As to the constitution of C and Me, we have no information. The C_2 in C_2 is probably the doubled molecule of Carbon whi occurs in so many zoogenic compounds. The com position of Me is such that it may be represented $Cy_3;N$, that is, as Ammonine H_3N, in which eve atom of Hydrogen is replaced by C_2N.† Let now consider the nomenclature of the Basistyles these styles of the first order. Since they are ea composed of an autostyle combined with a bas we may call them as a class "Autostylobases; those of them whose styles are halogens we m term "Halobases." We have thus—

Halobases, —Alkalies and Alkaloids.

58. *Definition* 7. A Halobase is a Salt having Halogen for its style. We may indicate the su

* Phosphorus is perhaps an exception from the Halogens this point.

† It must be stated that Gerhardt assigns to Mellone a co position ($C_{12}H_3N_9$) which is not in accordance with this suppo tion, but seems to indicate that Mellone is a trebled Ammoni (H_3N_3), having six of its atoms of H replaced by Cy. Accordi to Gerhardt, Mellone is not a style, for he represents the Mel nide of Potassium as $Cy_2H\,K_2N$, that is, as Mellone which is r combined with K, but which has two of its atoms of H replac by K.

divisions of this class acording to the different species of Halogens which they contain, as *Sulfo*-bases, *Fluo*-bases, *Chloro*-bases, *Oxy*-bases, etc.* The "Oxybases," it will be observed, are a very important order of compounds. An Oxybase bears to the general idea of a salt and to Oxygen a relation just the converse of that which a Hydrostyle bears to that idea and to Hydrogen. The term Oxybase includes the Alkalies, commonly so called, just as the term Hydrostyle includes the acids. The term "Alkali" may be properly restricted, according to its usual though undefined acceptation, to mean such an oxide of a base as is soluble in water. In this limited sense alone I shall use the term Alkali, as thus denoting the corresponding "antilogue,"† or opposite analogue, of an acid.‡ The term alkaloid is often used without

* On the same plan we may construct general terms for the Salts or Basistyles of the different bases. Thus as we have called those having Hydrogen for their base Hydrostyles (see § 41, p. 29), we may use the words Kalistyles, Sodistyles, Ferristyles, Argentistyles, etc., for the Salts having Potassium, Sodium, Iron, Silver, etc., for their bases. Again, since some molecules which are basic also fill other positions in Salts, we may require a more general term to express Salts involving such molecules either as bases or in any other position. Thus we shall have Ferrihales, any Salts containing Iron as an important constituent; Stannihales, Salts containing Tin; Kakodylohales, those containing Kakodyle.

† I shall use the term "antilogue" to express a thing analogous in an opposite sense to another, and "antilogy" to signify analogy in contrariety.

‡ See note to § 107, p. 85.

any precise signification, as vaguely indeed as th words "acid" and "base" have been applied, bu denoting "something like an Alkali." This notio of likeness gives considerable margin for variety o acceptation, according to the direction in which th likeness is recognized. A body, for example, ma resemble an Alkali, either in being soluble in wate or in containing oxygen, or in depending for it chief qualities on the basicity of some body whic it either contains or helps to constitute. The wor Alkaloid has been so loosely applied in the last tw of these senses that it has no claim to be devote to either; and, in the system of nomenclature whic I have to propose, bodies enjoying both of thes resemblances to an alkali will be provided severall with more definite names. I shall then, findin this word "alkaloid" without a fixed occupation assign to it the service of denoting any halobas which is soluble in water.

Nomenclature of Halobases (*ade* terminal).

59. We have now to consider the specific name of the several Halobases. Under the prevailin nomenclature their names are compounded of word terminating in *ide* formed from the nam of their halogen, prefixed to the name of their bas in the genitive case, thus, Fe:O, Oxide of Iron Na:Cl, Chloride of Sodium. But to certain of th Oxybases a name of a different and much mor convenient form is given; thus we have KO, Po tassa; Ba:O, Baryta; Mg:O, Magnesia, etc. Nov the vowel termination *a* happens by its priorit in the alphabet to be suggestive of unity, and so

of the fact that in each of the compounds thus named there is but a single equivalent of Halogen;* this unintentional coincidence of fashion with a most useful principle in nomenclature is very convenient. From these two methods of nomenclature I would derive another, combining the advantages of both. Taking the brevity and the terminal vowel of the one set of names, and the characteristic *d* of the final syllable of the others, I would reduce each name into a single word involving both the name of the Base and that of the Halogen; I would terminate the word with "ad," or, according to the English orthography, with "ade," whereof the *d* will indicate, in conformity with common usage, that the styles of the compounds are autostyles, while the *a* denotes that there is but one atom of such style present. Thus the salts of each of the halogens may be denoted collectively by the general terms "Oxades," "Fluorades," "Chlorades," "Sulfades," etc. etc. We may of course retain the genitive particle "of" to connect the name of the style with that of the base in the specific name of each salt; thus Fe:O, Oxade of Iron; Na:Cl, Chlorade of Sodium; Ag:Cy, Cyade of Silver; K:Me, Mellonade of Potassium, etc.; but it would be more convenient in most cases to compress our

* This is the case with all the compounds to which names of this form are given, except Si,O_2, to which indeed, containing three atoms of O, the name Silicia is not often applied by chemists. I shall state hereafter why I consider Alumina, commonly written Al_2O_3, is not an exception to this unpremeditated rule.

terms into single words; thus, for the species here cited, Ferr-oxade, Sodi-chlorade, Argenti-cyade, Kali-mellonade, it would still be permissible to drop the name of the style Oxygen and the *d* or *de*, and retain the vowel termination *a* in the cases of the Alkalis or of oxades of the stronger bases.

Water, acting as Salt, —Hydra.

60. We may thus also, when speaking of water in any capacity in which it acts by virtue of its saline nature, apply to it the term "Hydra."

Instances of the above nomenclature.

61. On the plan just stated we may take the following terms as more general expressions. Thus all the Salts of the autostyles will be Autostylades; thus "Halade" and "Basalade" may be used as synonymous with "Halobase," for any salt having a single molecule of Halogen for its style. "Hydralade" may denote any such compound having hydrogen for its base; so *Kalalade, Ferralade* would mean any halogen salt of Potassium or of Iron. Now there is no reason why the compounds of Hydrogen should receive names of a form different from those of the other bases; thus to the hydrostyles, or acids having autostylic styles, we may give the general term "Hydrautostyle." Hydralade may denote any such compound having a single molecule of a halogen for its style. For the several hydrostyles of Fl., Cl., S., Cy., we should have the specific names Hydro-fluorade, Hydro-chlorade, Hydro-sulfade, Hydro-cyade. There is no necessity for or advantage in repeating in the name of each species that of the class to which it belongs: we do not consider it necessary to call K:O;H:O and

Na:O; H:O Potassic alkali and Sodic alkali; still less should we think of calling them Oxy-potassic and Oxy-sodic alkali; Potassa and Soda are sufficient. And in the case of these acids the prefix "hydro" will most efficiently denote their nature, namely, that they are hydrostyles: custom however has in nomenclature separated them entirely from their similars, bestowing on them peculiar two-worded names consisting of the term "acid," with a specific epithet. Some chemists who include under the general term "acids" both the different classes of bodies which we have above separated, namely, those which contain basic Hydrogen and those which contain no base, yet, by way of marking between them the distinction which they notwithstanding recognize, give the term Hydracids to the former class; and some authors apply this term more expressly to the members of our first order within this class of hydrostyles; but, by a curious aberration of method, they all avoid applying to the species this generic term "hydracid," which they give to the group, and here use the term acid instead of it: thus for Muriatic acid, H:Cl, we have now the name Hydrochloric acid; for Sulfuretted Hydrogen, H:S, Hydrosulfuric acid; for Prussic acid, H:Cy, Hydrocyanic acid. According to all ordinary and logical rules of nomenclature in Natural History, the name of a species, if it is to be two-worded at all, ought to consist of the generic or at least of the classical name, with a trivial or specific name appended. Thus the names

of these bodies, under the Hydracid terminol
ought certainly to be Chloric Hydracid, Sulfi
Hydracid, and Cyanic Hydracid.

.cid,— ıould be ɔmpound ɔluble in ater of Hy- rogen, a ase with lalogen.

62. If however we adopt, as I think we ou
the name acid for these compounds of basic I
drogen with a Halogen, and restrict it to such
them as are soluble in water, the term Hydra
becomes superfluous. Now it happens that all t
Hydrostyles of this first order are included un
the term "acid," with the restricted sense wh
we have assigned to it; all of them being m
or less soluble in water; so that if we admit t
adjective and substantive form of name, we n
retain the term acid in this application; and if
use the term acid at all, we are almost compel
to give to these species respectively the simp
names Chloric acid, Sulfuric, or, better, for a r
son which will hereafter appear, Sulfic acid, a
Cyanic acid. We have, with this use of the te
acid, no necessity for the suggestion of Hydro
in the appellation either of class or of species,
its presence is implied, according to our definiti
by the term acid. Chemists will object very stron
to call the three acids which I have instanced
these simple names, because they will prefer to
tain them for compounds to which they are alre
applied; but I am sure that every naturalist
allow that the simpler object ought to have
simpler name, and the more complex compound
longer appellation. On the ground of conform
to nature, I ask, Which substances are the m

ntitled to the simpler names, those that are re-
resented respectively by H:Cl,—H:S—H:Cy,—
r those of which the formulæ H:O;Cl,OOOOO,
—H:O;S,OOO,—H:O;Cy,O are the symbols?
There can be but one answer from any unpreju-
diced person. And this is the more certain when
it is considered that the complicated compounds
which at present are favoured with the shorter
names are quite as well qualified as are the simpler
ones for the very titles which are bestowed on these
latter, since the former also contain Hydrogen in
exactly the same position as do these. The simpler
terms, if appropriated to the simpler acids of the
first order, exactly express their composition to any
one who remembers our restricted definition of an
Acid.* New names would of course be required
for the many-moleculed bodies, which would be de-
prived of their names if these terms were appro-
priated to the hydr-autostyles; nothing is more
easy than to construct for them words which shall
exactly express their composition. We shall soon
be led to this point again, when we proceed pre-
sently to the next step in our analysis of Salts,—
the consideration of the second group of Hydro-
styles.

Section II.

Of Multiple Salts having Styles of the First Group.

63. There are many multiple salts whose mem- Distinctive formulæ for these desirable.
bers have styles belonging to this group. It is

* See § 23, p. 16.

desirable that we should have precise modes of representing these salts by formulæ, and of naming them so that we may not confound them with compounds of other kinds. We have already fixed the meaning which we shall attach to the terms Multiple Salt or Polyhale, and Double Salt or Diplohale, the latter being a particular case included under the former general expression.* In future stages of our discussion we shall find that a considerable degree of interest is attached to certain compounds of this kind, especially to certain double salts; it will be well therefore if we obtain at once as distinct a notion as possible of the nature of such systems.

Multiple salt presumably of like bi-polarity with its constituents.

64. As to the mode in which, or the kind of force by which, the saline molecules are held together, we have at present no information; we know however that these component monohales are similar to each other in constitution when existing in the separate state, and we do not know that the previously established bipolar arrangement of any of them is disturbed by their union in the multiple salt; so that the simplest notion we can entertain of the Idea of a multiple salt will be that of a faggot or bundle of bipolar molecules tied together in positions parallel to the direction of the force by which each is constituted, and having their similar poles towards the same part. Thus, if we compare a single salt to a ferromagnetic bar, a multiple salt will be likened to a number of such bars

* See § 20, p. 14.

laid side by side with the similar ends in the same direction. According to this idea the multiple salt will enjoy the same bipolar nature that belongs to each of its constituents, and, like them, may be amenable to the voltaic analysis, yielding in such case all its bases at the cathode and all its styles at the anode. But it is possible that the voltaic attachment which holds the several styles and bases together in the single salts may be, in some cases, modified by the forces which unite them into multiple salts, so that the analysis of the pile will no longer separate them in the usual manner.

Mode of depicting multiple salts.

65. In representing, then, multiple salts by formulæ, it will be most natural to place the symbols of the component single salts symmetrically with respect to each other, unless we have special reason for supposing that the parts which they severally play in the compound are not precisely the same.* And we must not lose sight of the cardinal fact of the voltaic bipolarity of each of them, according to which there is a central point in each about which it is balanced, not as to the number or weight of the atoms on each side thereof, but as to the direction of their attachments. This point in a single salt I have proposed to represent by a colon, thus, H:O. The simplest and most logical mode then of depicting a multiple salt will be to write down the several component single salts one beneath the other, with the central or neutral point of each

* We shall hereafter meet with cases in which there is reason to suppose that the two saline members of certain diplohales are not chemically symmetrical with each other.

exactly under that of the salt next above it;*—ju as in preparing arithmetical quantities for additi we place the decimal points of all the numbers i a vertical column; so that, as we have a neutr point in each single salt, so we should have a neu tral line or axis in the multiple salt. Such an a rangement involves the smallest amount of assump tion that can be made as to the potential positio of the several members with respect to each oth in the actual salt. Further, we may, of cour without asserting anything positive as to their r lative powers in the compound, follow some rule a to the order of their superposition in the column thus we may very naturally write down first tho single salts whose members we believe to be unite by the strongest attachment, and below them, i succession, those salts whose constituents seem t be less energetic; and on the principle of repre senting all uniting forces, in our pictures of com pounds, by definite marks, each monohale may b separated from its neighbours by horizontal line drawn between them. Further, at the same tim to simplify the notation and more strongly to indi cate the union, we may draw a line down throug all the mesial colons, leaving a point at top an another at bottom, to remind us of the polarity this line may be taken to represent the resultan of the forces which may be supposed to act throug

* We shall hereafter have occasion to discuss certain doub salts in which there may be reason for varying this form, an not placing the bases exactly under each other.

the Bases and the Styles respectively on opposite sides of the neutral axis, and by which the several salts are held together; it may be called the "coupling axis." So then a double salt will be indicated by a single cross, thus $\frac{B \dagger Ha}{B' \dagger Ha'}$, the cross being repeated for multiple salts of higher degree, thus—

$$\frac{\frac{B \dagger Ha}{B' \mid Ha'}}{B'' \dagger Ha''}$$

According to this method we should arrange the formula of the "Double Chloride of Sodium and Silver" as $\frac{Na \dagger Cl}{Ag \dagger Cl'}$, and the "Hydrated Oxide of Copper" as $\frac{Cu \dagger O}{H \dagger O}$. When one of the component Single Salts is repeated in the system, being present in more than one equivalent, this may be denoted by an index number, thus—

$$\frac{K \dagger Br}{Mg \mid Br} \qquad \frac{K \dagger Cl}{(Mg \mid Cl)_2}$$
$$(H \dagger O)_6 \qquad (H \dagger O)_{12}$$

This mode of formulizing the polyhales has been already referred to;* it is that which I shall always use.

Symbols of Monohales, Diplohales, etc.

66. As we represent a Monohale by the diagrammatic symbol —+—, so we may represent a Diplohale by the figure =+=, a Triplohale or treble Salt by ≡+≡, and so on. It is important to observe,

* See note to § 33, p. 23.

that in a Multiple Salt either the Bases or the Styles of the several component molecules may be the same or different respectively: even all the Bases and all the Styles may be different. Attention however is most commonly directed to those polyhales in which only the Bases are different from each other; and there is even a tendency to consider a multiple Salt, whose members have different Styles, a strange compound, except when the O. of Water is the varying Style. It is considered quite normal that water should occur in company with the Salts of other Styles; but there is in nature no real exception here in favour of the halobase. I have already cited instances of the better-known class of polyhales, in which the Bases are different; the following are examples of such compounds having the Styles diverse:—

$$\frac{Pb}{Pb}\,\Big|\,\frac{Cl}{F} \qquad \frac{Hg'}{Hg'}\,\Big|\,\frac{S}{I} \qquad \frac{(Ag}{(Ag}\,\Big|\,\frac{Br)_2}{Cl)_3} \qquad \frac{\frac{Sn}{Sn}\,\Big|\,\frac{Cl}{O}}{(H\,|\,O)_3}$$

A greater number of polyhales thus varied are to be found among Salts having complex styles: we shall hereafter encounter a few such compounds.

menclature of Monohales and polyhales to correspond.

67. In constructing names for the polyhales having styles belonging to this group, we should adhere to the same form which is adopted for the corresponding Single Salts: thus we should retain the characteristic *d* of the final syllable. When either the Bases or the Styles of all the monohales of which the system is composed are the same, the name of the multiple Salt may be tolerably short,

names of all the Bases being introduced into
ollowed by that of the common Style, with the
ropriate termination; but the unit letter *a*
st be dropped from the terminal syllable. The
ree of the multiplicity of the Salt may be con-
iently expressed by varying this part of the
ne: thus we may introduce into it a vowel
ch shall express the number of molecules of
le, and consequently of Single Salt in the com-
nd: as *a* represents 1, *e* may be taken for 2,
r 3, *o* for 4, *u* for 5; and higher numbers may
denoted on the method of addition, thus: for
1+5 we put *au*, for 7=4+3, *oi*, etc. The
ecules of water of crystallization in a salt may
expressed separately as "Hydra,"* since it is
erally the members containing metallic or com-
bases that are of chief importance. Thus
may call the salt $\frac{Na}{Ag}\frac{|Cl}{|Cl}$, Sodargenti-chlorede;
$\frac{Cl}{F}$, Plumbi-fluo-chlorede; $\frac{K\,|\,Cl}{Mg\,|\,Cl)_2}{H\,|\,O)_{12}}$, Kali-di-
nesi-chloride: if an exact description of the
talline Salt be required, the prefix "dodec-
ra" may be joined to the latter name. Since
main purpose here is the anatomy of Single
s, we need not occupy space with additional
mples of polyhales.

* See § 60, p. 48.

CHAPTER III.

OF STYLES OF THE SECOND GROUP.

Section I.

The Parts of Styles of the Second Group.

Hydrostyles of this group how composed.

68. It will be observed at once that there is a uniformity in the construction of all our Hydrostyles of the second group. We have defined their Styles thus:—"such as, being complex, are not known separate from a base as single bodies, but may be divided into definite submembers, one of which is by itself a style, and each of which may exist separately, while by joint reunion with a base they will together again form a salt containing the original style."* The Stylic member of each of the examples which I cited from this group, in a former page,† $H:O;S,O_3$—$H:O;C,O_2$—$H:O;N,O_5$—$H:O;Si,O_3$—$H:S;As,S_5$—$H:F;Bo,F_3$, is constructed on the same type. It consists in every case of a Halogen which forms by itself one submember, and of a second submember which contains a further quantity of the same

* See § 51, p. 40.

† See § 54, p. 40.

Halogen that constitutes the first. Further, there is a marked uniformity in a great number of cases in the plan of these second submembers on the Stylic side. Each such consists of a single molecule of some element, which, it appears, may be either a Zoogen, a Halogen, or a Geogen, united with a certain quantity of that Halogen which recurs in repetition, as it were, of the other submember. In the greatest number of cases the Halogen thus recurring presents two, or more than two, of its molecules in the second or complex submember of the stylic side of the Salt. There are, in fact, comparatively few instances, besides those of which the remarkable compound halogen Cyanogen is a constituent, in which only one molecule of halogen is found in this part of the hydrostyle. Thus each of these complex hydrostyles consists of a hydrostyle of the first order, with the addition to it of a supplemental compound, which generally repeats the Halogen of the former.

Second submember of each style a pseudo-acid, or on same plan.

69. The next fact that strikes us with respect to the constitution of these hydrostyles, is that the second submember of each style is a system of molecules formed on the plan of the second sort of bodies confounded under the term "acids" in the received nomenclature. Several of these, in the instances I have taken, are the very compounds which I was compelled to cite as the commonest species of these pseudo-acids;* in fact it is precisely these sub-

* See § 24, p. 17.

members of our second order of hydrostyles that have been thus undeservedly raised to the titular dignity of acids. It is with these very acids, by courtesy, that we have now to deal, in discussing this part of the subject; so that we shall determine due titles for the second pseudo-class of so-called "acids" at the same time that we dispose of our true second order of veritable hydrostyles.

How these complex styles are formed, *e. g.* the Sulfates.

70. Let us first consider how these complex styles or their basistyles are formed, that we may get some hints for naming their parts. Let us take as an example the Sulfates, as those salts are at present called, whose general formula is $B{:}O;S,O_3$. If to water (H:O) the metal Potassium (K) be added, the metallic base acts violently on the water, decomposes it, expels Hydrogen, and forms a new compound, which remains in solution (K:O). If previously to the introduction of the Potassium the compound called "Anhydrous Sulfuric Acid" (S,O_3) be added to the water, this substance is vehemently dissolved and the mixture becomes heated, but no decomposition ensues. If now to this mixed liquid Potassium be added as before, it acts on it with greater energy than it did on the pure water, decomposes it, and evolves Hydrogen just as it did in the former case. But a new compound is now found to be in solution, which is not K:O, but may be represented as $K{:}O;S,O_3$. But we do not know that the Sulfur of the compound S,O_3 has entered into the new salt thus formed in any such way as to have got

between the Potassium and the Oxygen, which we found in the first salt (K:O). We know that the water, after the accession to it of the S,O_3, contained the true acid called the Sulfuric Acid, which may be written as $H:S,O_4$, but which it is more reasonable to symbolize as $H:O;S,O_3$, for we do not know that the Sulfur has insinuated itself into the water in any such way as to entitle it to be represented as lying between the Hydrogen and the Oxygen of the water. We know that it has adhered to the water with great force, and we know that it lies, with reference to the bipolar nature of the salt, on the same side voltaically as does the Oxygen. We may fairly say therefore that it has adhered to the Oxygen of the water: we cannot say either more or less than this as respects the composition of the acid thus formed. We are entitled therefore, and bound, I think, if we write water H:O, to write this acid as $H:O;S,O_3$, the punctuation of course being matter of taste; and since the Potassium takes the place of Hydrogen in forming the salt, we must write this substance down, not as $K:SO_4$, but as $K:O;S,O_3$.

Variations from type with nature of adjunct of style.

71. This may be taken as a typical instance of the mode of formation of hydrostyles of this second order and of the other corresponding salts. The subordinate phenomena of the process in different cases will differ considerably according to the nature of the adjunct or adhering submember of the style in each species. These variations may depend on differences of solubility of the com-

pounds concerned. The formation of the Sulfate of Potassium which I selected for illustration is more simple in description than that of most others, by reason of the stability and solubility in water of every compound which has to be mentioned. The very different degrees of energy with which the adjunct adheres to the primary hydrostyle is one principal source of variety in the detail of the process. The variation in the energy of this force of adhesion extends from a maximum at which we cannot directly separate the adjunct from the original simple hydrostyle when once united to it, through numerous intermediate steps of intensity, down to a minimum at which the two bodies will not unite at all, though they will co-operate together in the formation of complex salts with other Bases. In these latter cases, though the adjunct will not adhere to the simple hydrostyle, it will adhere of course to the corresponding salt of some other Base with the same simple style, though perhaps not to all. This peculiar secondary attachment seems to be compounded of two forces, one of which resides in the adjunct, and determines the general latitude of its combining tendencies, while the other is derived from the Base, the energy of which we must suppose polarizes the Halogen of the simple salt by a kind of induction, and enables it to associate to itself the supplemental molecules. Thus the adjunct C,O_2 (vulgarly called "Carbonic acid") will not combine at all with oxide of Tin (Sn:O); it adheres to

water (H:O) with so little force, that a slight elevation of temperature will expel it. From oxide of Zinc (Zn:O) a heat below redness will detach it; a high red heat and the aid of steam is necessary to sunder it from Lime (Ca:O); no heat, nor any force that we can apply to the compound, except the superior chemical attachment of some other body, such for example as S,O_3, will suffice to dislodge it from Potassa (K:O).

Potential complex hydrostyles.

72. Again, Pentasulfide of Arsenic ($As S_5$) is not known to combine with sulfuretted Hydrogen (Sulfuric acid or Hydrosulfade, as I would call it); but the action of these two bodies together in appropriate circumstances on Potassium produces a determinate complex salt, the "Sulfarseniate" of Potassium ($K:S;As S_5$). In this instance the agent of the combination ($H:S;As S_5$) is hypothetical as a *compound;* but potentially, as a *complex* hydrostyle, in the general sense above assigned to the word complex,* it has a place in our system. The metallic salts which correspond to it, and which we know, are evidently built upon the same model as those others whose co-ordinate hydrostyles can be made and kept. It appears that the molecule $As S_5$ and some others of analogous construction, especially some which contain Sulfur united to one or other of a certain few metals, have a tendency to attach themselves to the hydrostyle H:O in preference to H S; thus in fact the complex hydrostyle which we find containing this molecule is $H:O;As,S_5$. From this

* See § 28, p. 20.

compound the other salts are formed by displacement of H:O by the sulfide of a base (a sulfade). This is an exception to the usual prevailing rule of the repetition of the halogen in these complex styles.

Whether any voltaic relations of molecule in compound.

73. It must be remembered in the case of complex Styles and Bases, which latter we shall discuss hereafter, that the whole group of molecules which together form the Style or Base is the volta-negative or positive member of the salt or acid. We do not know that the separate molecules of the different elements of which each such member is made up, or that any set, of several of them, fewer than those which constitute the entire member, are volta-negative or positive in the resulting salt or acid, either towards the opposite member of the salt or towards another part of the member or sub-member in which themselves are placed. We have in either case a complex molecule more or less strongly negative or positive, but we have no information from this fact about the state of the component parts of the Style or Base. Nor can we draw any inference from the position of these minor groups, or elementary molecules in the salt, as to their condition severally considered with respect to the voltaic force, either during their sojourn in the compound or when in the free and isolated state. In most cases we have not the slightest reason for thinking that they have any voltaic or bipolar relations within these compounds, but considerable grounds for concluding that they have not.

4. We now want some new general terms to ress these constituent parts of complex salts. stly, we want a more definite term for adjuncts ch may attach themselves to the halopoles of s. They may be said to be applied upon (ἐπί) se poles; we may therefore conveniently call m "Epipoles," defining the term thus:— *Definition* 8. An Epipole is a molecule which n combined with simple salts converts them) complex salts. Adjuncts of halopoles,—epipoles.

5. The adjuncts or epipoles, which we are now sidering, next require a special designation. y have a very marked and definite character, te as distinct as that of the hydrostyles; and re being no confusion in our conceptions of ir nature, there is no reason for keeping up a fusion in our names. The old nomenclature ibled them, under the term "acids," with our drostyles of the first order, and with the "hystyles" of the second order, which latter are ned from certain of these adjuncts themselves the addition of a hydrostyle of the former sort. y were indeed sometimes distinguished from se, their own compounds, by the addition of the ective "anhydrous;" but this merely negative het, meaning "waterless," has no distinctive ning as applied to such bodies as Pt,Cl_2,—Bo F_3, s S_5, etc., which do not require water for the pletion of their "acid" properties. This objec- holds with equal force against the term "anhye," which has been given to these bodies by Epipoles to stylos,—Epistyles.

some French chemists. It is only as applied to such bodies of this kind as contain oxygen, and by combining with water form hydrostyles, that these terms express any important fact. Again, many epipoles of this class, such as the adjunct ($C_6H_4O_4 + H:O$) of Lactic acid ($H:O;C_6H_5O_5$), may be represented as actually containing water. Finally, water itself seems sometimes to take the place of such an adjunct, and to call water a waterless body would be absurd. But the primary function of these bodies is that of attaching themselves to the styles of the simpler salts, suggests for them the term "Epistyles." This term, then, I shall use for bodies having such chemical "combining" tendencies as belong to C,O_2,—S,O_3,—Pt,Cl_2, etc.,—defining it thus :—

Definition 9. An Epistyle is a molecule which when in combination with simple salts forms salts having a complex style; thus an epistyle is a particular case of an epipole.

Salts with epistyles,—epistylobases.

76. This, then, is a particular mode of complexity of the style of a salt, namely, that which consists in containing an epistyle. We may require a term to designate such salts as have this special complexity, as distinguished from any other form with which we may meet; any such compound then, may be called briefly an "Epistylobase."

Salts or Stylobases attaching epistyles,—prostylobases.

77. We next want a general term for such stylobases as take up the epistyles, and so form more salts with complex styles. Now an original salt to which an epipole attaches itself is the first (πρῶτος

: of the system lying in it or indeed constituting efore (πρό) this addition; I have therefore ɔd it the *Prohale* (ἅλς). And in a salt in which pistyle is attached to a stylic halogen, the latter ıe primary part of the style; it may therefore alled the *Prostyle*. And the salt or stylobase f to which an epistyle is, may be, or has been ched, may be called a "Prostylobase."

3. Further let me add, that as a Prohale may an epipole on either of its poles, so there are which may take an epipole on both of their s. Such a fundamental basistyle, when so pleted, may be said to lie within (ἔνδον) the re complex salt; it may therefore be called an ndohale." Salts with epipoles or both poles, Endohales.

9. We may define these terms thus:—

efinition 10. An Endohale is a salt which has, nay have, an epipole attached to both its poles. Definitions Endohale

0. *Definition* 11. A Prohale is a salt which or may have, an epipole attached to one of its s. Prohale

1. *Definition* 12. A Prostylobase is a salt which or may have, an epistyle attached to its style. Prostylobase

2. *Definition* 13. A Prostyle is the style of a stylobase.—It will be seen that since it is only, almost only, to the salts of the Halogens that tyles attach themselves, prostylobases are gener- y or *always* Halobases. A prostylobase is a icular case of the prohale. Prostyle

3. We may use the more general terms "Endo- s" to express the Halogides of an Endohale, Halogide Endohale.

[redacted]

and "Propole" for the simpler pole of a Prole namely, that in which the epipole is or may [redacted]

Autopole. Autolyte. &c.

84. Now we may require a word to express [redacted] capacity of a molecule not containing an adjun to fill the place of a halopole, in virtue of its o valent attachment, not as an epipole nor as requiring an epipole to complete its stylicity or [redacted] ciety. Such a body then, being itself (αὐτός) pol I would call an "Autopole;" similarly I wo denominate the two kinds of autopoles, namel such as are of themselves stylic, "Autostyles,"† such as are of themselves basic, "Autobases." A salt both of whose poles are autopoles may, on the analogy of our other terms, be called an "Autohale." The Halogens, it will be observed, are autostyles; prostyles are always autostyles. An *autopole* may or may not act as an endopole or propole; this is a distinct point in the physiology of the Halopoles. Every propole however must be an autopole.

Section II.

Of Epistyles.

Epistyles not volta-negative or stylic.

85. What then is the chemical nature of these pseudo-acids, or epistyles, which may be attached

* In the punctuation of formulæ I shall always use a semicolon to indicate the separation and connection between the epipole and propole of complex poles, and this stop will never have any other meaning in my formulæ for salts.

† See § 57, p. 44.

We must make this inquiry;
s, like the salts into which they
te forms of constitution, we must
ns to express the parts of which
ey are quite devoid themselves of
stylic energy; they are utterly
ne with true Bases, metallic or of
n. When these adhere to the Ha-
ses, the Halogens, taking them
, resign that absolute volta-nega-
hich as autostyles they enjoy, and
body thus joined to them.

s to the greatest number of the with the ten entire styles* of parts, we have no evidence what-ements of which they are com-ted to each other, that they can two members, which are volta-native respectively. In the great-nses we have strong reason for e voltaic attachment is not the hey are constituted. By far the certainly cannot be directly de-voltaic current. They are not re not true salts; though among hich, consisting of a metal united have a resemblance in composi-n certain properties, to metallic

Generally not voltalytic.

of them real salts,

Some true salts capable

* See § 73.

of acting as adjuncts to others.

which enjoy this property of attaching themsel to the stylic side of other salts, in addition to properties which characterise the more typical nary compounds. The Cyanide of Iron (Fe:Cy) an instance of this doubtful nature. This body apparently a bipolar compound containing Ir Iron, yet it acts as an adjunct in forming a m remarkable series of complex salts, which h other peculiarities of constitution. Water (H:O) seems in some cases to enter into combin tion in this way as an adjunct to the oxides a to the Sulfides of certain metals; thus, for in stance, it seems reasonable to consider the hydrate oxide of Calcium (Ca:O;H,O) as a body analogou in constitution to the Carbonate of the same meta (Ca:O;C,O_2), since either of these adjuncts to th oxide may be made to expel the other and to take place in the compound in its stead.

Fundamentally, one molecule, simple or compound, with several proportionals of Halogen.

88. But by far the greater number of these bodies consist of a single molecule of some element or of a compound molecule united to a plurality of proportionals of a Halogen; and it is this which distinguishes them generally from Salts, and marks them as belonging to a different type; and in the greatest number of cases the body attaches itself to salts which have for their style the same Halogen as that which thus characterizes itself. This seems to be the fundamental Idea of these compounds. The first part of the epistyles has an obvious chemical analogy to the base of a salt; indeed, in several cases, besides those in which the epistyle itself

saline nature, this molecule is one which is found with basic properties in certain true

. The molecules constituting the second part e epistyles are always of stylic capacity: in reater number of these bodies that are at pre- known, this Halogen is Oxygen. These Oxy- us epistyles may be taken as the types of the

Typical Epistyles Oxygenons.

. The Epistyles then are of a form so constant definite that we must have names for the parts hich they consist. Their general formula is Ha_n, and that of the salts which contain one em is $B:Ha;Ab,Ha_n$. Here B denotes any ; Ha any Halogen; n a number of molecules, h varies in different kinds, but does not exceed any epistyle of which the constitution is cer- y known; Ab a molecule which may be sim- r complex, and which occupies in the epistyle ition somewhat similar to that of a base in a for example, of the base in any prostylobase which the epistyle itself may combine, which it usually resembles in being united with the halogen, though commonly with a plurality uivalents thereof.

General formula of Epistyles.

. No term is current in chemical language to nate strictly and solely such molecules as the place of Ab in epistyles or in salts; some cules of this kind have been sometimes called dicals,"* but this term is very vaguely applied,

Molecule of similar position to base in epistyle or salt,— Antibase.

* The term "Radical" is generally used to signify a complex

and is not suggestive of any particular function
meaning, so that I shall not use it. A word
absolutely necessary to express restrictedly t
part of the salt system. Let us coin the wo
"Antibase," and apply it to this use as a gene
name for all such molecules. This term will su
gest the analogy of its objects to bases, and will
the same time remind us of the difference in th
nature, which gives to their compounds with t

group of atoms, which determines by some marked character t
nature of the bodies into the composition of which it enters;
is commonly supposed too to imply that such molecule seems t
play the part of an elementary atom in the formation of com
pounds. The expression "acid-radical" has been loosely use
to denote a section of the genus radical, being applied to suc
complex groups for the most part hypothetical, as for exampl
S,O_4, such as form the styles of our acids of the second orde
It has also been bestowed upon imaginary molecules, which, bein
supposed to contain Oxygen, by the addition of more of that el
ment and of water would become hydrostyles. Thus, for exam
ple, C_2O_2 is said to be the "radical" of "Oxalic Acid," which a
this theory would be represented as $H:O;(C_2O_2)O$, and the fi
titious Benzoyle, $C_{14}H_5O_2$, is called the radical of Benzoic Acid
which is thus to be represented as $H:O;(C_{14}H_5O_2)O$. Again
other sets of atoms which do not contain Oxygen, but which b
assumption of a certain amount of it, and addition of water, b
come hydrostyles, are called radicals. Of this kind "Acetyle
C_4H_3, and "Kakodyle," $C_4H_6As_2$, the latter of which is an a
tual substance, are examples. The first of these bodies is prob
bly the real antibase of "Acetic Acid," $H:O;C_4H_3,O_3$; the latt
is the Antibase of Kakodylic Acid, $H:O;C_4H_6As_2,O_3$. It is o
vious that the molecule, which in "Oxalic Acid" corresponds
these so-called radicals of "Acetic" and "Kakodylic Acids,"
not C_2O_2, but C_2, so that these two sorts of radicals are distin
The same term is applied to bodies of yet another kind, nam
to bodies which, being basic, yet by loss of Hydrogen, the

Halogens habits different from the normal properties of Basistyles, it will also recall the fact that in salts they lie not on the same side with the base, but on the opposite (*ἀντί*): by its chemical analogy to the base of a salt, the antibase claims to be considered as a basoid.* The Antibase may be said to be the "denominator" of the epistyle, since it determines its special nature in a peculiar manner, and is, very properly, always taken to give the

placement thereof by Oxygen, and the addition of more of that element and of water, yield hydrostyles, in whose stylic member the rest of their material is involved; thus from the "radical" Amyle, $C_{10}H_{11}$, "Valerianic Acid," $H{:}O; C_{10}H_9, O_3$, is evolved.

Thus if we represent a body corresponding in function to O or to "SO_4," *i. e.* a style, by *st*; such a molecule as SO_3 or C_2O_4, *i. e.* an epistyle, by *est*; such a one as C_2O_2 or $C_4H_2O_2$, by *x*; such as C_4H_3, by *y*, and as $C_{10}H_{11}$, by *z*, and the term radical by *rad*, we obtain from the above instances the following equations:—

$$\begin{aligned}\text{Acid or Hydrostyle} &= H{:}st = H + rad.\\ &= H{:}st, est.\\ &= H{:}st; x, O = H + rad + st + O.\\ &= H{:}st; y, O_3 = H + rad + st + O + O_2.\\ &= H{:}st(z-2H)O_3 = H + rad + st + O + O_2 - H_2.\end{aligned}$$

Of the different lengths of material which may thus be supposed to be cut off, as it were, in succession from the style of a complex hydrostyle, beginning with the whole style and ending with a part not to be found complete therein, the name "radical" has been given to all except one, and that one, the epistyle, is the only one that is represented by a numerous well-marked set of isolable compounds; and besides this use, the same term is equally often applied to basic molecules. From this it is evident that, whatever may be the value of the term "radical," it has no definite meaning in the anatomy of salts, which is our present business.

* See note to § 109, p. 88.

form to its name. In the perfected style or basi-style it may be said to be the "Link" or "Copula," since it seems to serve the purpose of uniting the secondary molecules of Halogen in the Epistyle to their fellow in the prostylobase. The Antibase may [redacted] a particular case of an "Antip[redacted]which we shall hereafter find a [redacted]

Metastyles, with antibase, form epistyle,—Dactyles.

[redacted]ules which form the rest of [redacted] called "metastyles," as bem[redacted]t not in the actual position [redacted] for this reason too they are to be classed among styloids. The metastyles may be said to be the "characteristics" of the epistyle, because they give the leading characters to its combining tendencies in determining to what salts it shall attach itself. We may also call them its "Dactyles:" this word is suggested by the multipolar, or, as it were, fingered form of most of these adjuncts, which distinguishes them from the bipolar compounds, the salts. We may thus characterize an epistyle, according to the number of its metastyles, as unidactylic (for example, Fe,Cy), bidactylic (f. e., C,O_2), terdactylic (f. e., S,O_3), quadridactylic (f. e., Os,O_4), quinquedactylic (f. e., $As.O_5$), septidactylic (f. e., $I.O_7$).

A kind of Metapole.

93. A metastyle will hereafter be seen to be a particular kind of "Metapole;"* of this term we shall find the meaning in the sequel.

* In the punctuation of formulæ I shall always use a comma to indicate the separation and connection between the metapoles

An Antibase may be said to be "basoid," responding in function to a base. A meta- may be said to be "styloid," as correspond- position to a style.

Antibase, basoid; metastyle, styloid.

We may then state these further Defini-

Definitions.

—

inition 14. An Antibase is a molecule which, nbination with a molecule or molecules of alogen kind, forms an epistyle.

(14.) "Antibase."

Definition 15. A Metastyle is one of the nles, usually of a stylic nature, which, in nation with an antibase, form an epistyle.

(15.) "Metastyle."

The metastylic molecules of an epistyle are y all of the same species; but we have a few ces, and no doubt shall find more, of epi- having one or two metastylic places occupied halogen different from that which holds the . Thus in "Sulfoxyphosphoric Acid," P,O_3S_2, are two metastylic atoms of Sulfur and of Oxygen; and in the recently described ydrous Sulfuretted Acetic Acid"* of Ke- C_4H_3,O_2S,† one atom of Sulfur replaces one epistyle of ordinary acetic acid. It is to be ked that this new epistyle attaches itself to lobases having S for their prostyle, the for- of its salts being $B:S;C_4H_3,O_2S$.

Epistyles, with different metastylic halogens.

ipole of epipoles, and this stop will never have any other in my formulæ for salts.

rnal Chem. Soc., vol. vii. p. 189.

ave interpreted the formulæ of the author into the ordi- tation.

Symbols of Epistyles.

98. Now as we have already agreed to represent a single simple salt by a diagrammatic symbol,* we may also denote an epistyle by an analogous figure. The epistyle is not usually a bipolar system, like the haplohale —+— but it consists normally of a single molecule with a plurality of atoms which are chemically antagonistic to it: in a manner polar to the former, but is not so obvious and, as it were, taking then, two, as the simplest case, we may denote the idea of an epistyle by a figure as —<, the horizontal line representing the antibase, and the diverging rays the metastyles. We may take special forms to denote such epistyles as have particular numbers of metastylic places. The greatest number of epistyles have three atoms of characteristic; all such may be denoted by the symbol —<; such is the terdactylic system S,O_3. Epistyles having other numbers of dactyles would be represented by symbols, with a corresponding number of rays. Unidactylic epistyles, such as Fe,Cy, or Cl,O, may be represented by —\ or —/, to distinguish them from salts whose two members are voltaically polar to each other.

Symbol of Epistylobase.

99. Again, our notion of a single salt with a complex style of this form is, that it contains an epistyle annexed to the prostyle of a prostylobase in such a manner that, when the salt is submitted to voltalysis, the epistyle comes off at the anode

* See § 37, p. 26.

along with the prostyle; we may therefore represent such an epistylobase by a symbol compounded of our sign for a haplohale with that for an epistyle, thus —+—<. The crosslet here represents the neutral point of voltaic fission, just as it does in the symbol of the haplohale, this point not having been moved by the annexation of the epistyle to the original salt.

Section III.

Of Styles containing more than one Epistyle.

Cases of Styles with more than one epistyle

100. There is another form of style included under the definition of our second order, which differs from those taken as the type of the group; these are such as contain more than one molecule of epistyle, with only a single prostyle. The following formulæ represent instances of this structure:—

$$Na:O;(Bo,O_3)_2$$
$$K:O;(S,O_3)_2$$
$$K:O;(Cr,O_3)_2$$
$$K:O;(Si,O_3)_2$$
$$K:O;(Sb,O_5)_2$$

The cases are rare and obscure in which more than two equivalents of isolable epistyle are found in any single salt; such structures however probably occur among the numerous compounds of SiO_3, with mineral oxybases. Salts containing two molecules of the same epistyle are often confounded, under the general term "bisalts," with systems of

a different structure, namely, with double salts, in which one of the two prostylobases is water, each of them having the same epistyle attached to it: thus the salts above cited are called Biborate of Soda. and Bisulfate, Bichromate, Bisili[illegible] and [illegible]e of Potassa; and the [illegible] called Bicarbonate of Soda, a[illegible]$_{10}$, which is probably $\frac{K}{H}$[illegible] Bitartrate of Potassa.

The Tartrelates.

101. The salts called Tartrelates, of which the hydristyle is formed by heating the epistyle of Tartaric Acid,† probably bear to the ordinary "Tartrates" the same relation which the "bichromates" bear to the "chromates." The following formulæ represent these salts:‡—

"Tartrates" $= B:O;C_4H_2,O_5$.

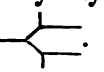
"Tartrelates" $= B:O;C_8H_4,O_{10} = B:O;(C_4H_2,O_5)_2$.

* See note to § 33, p. 23, and ch. iii. sec. 7.

† See a note in Sec. 7 of this chapter.

‡ We are not yet acquainted with any isolable double epistyles, properly so called; that is to say, we know no bodies that, consisting of two molecules of true epistylic form, combine with a single molecule of prostylobase to form a salt with complex style. Gerhardt's double epistyles (see Part II. ch. iii. sec. 9) and anhydrous lactic acid (see Part II. ch. iv. sec. 2) have the constitutions of such systems; but the former set of bodies are not known to have any epistylic combining power, and the latter compound takes two molecules of prostylobasic water. This latter makes the nearest approach to the nature of a true double epistyle, and is in fact as truly such a body as FeCy [Cyano-

Symbols of such Salts.

102. I would call such salts as have two epistyles attached to a single prostylobase, salts with doubly complex or duplex styles, or, more precisely, twin epistylobases;* they may be represented by the general diagram  .

Exepistyles.

103. The chlorohydrated sulfuric acid of Williamson† seems to be an instance of a twin epistylobase, containing two molecules of the epistyle SO_3 attached to prostylobasic water; one of these epistylic systems, having an atom of Cl, is substituted for one of metastylic O: its formula would be $H:O;\begin{cases}S,O_3\\S,O_2Cl\end{cases}$.‡ The secondary adjunct SO_2Cl, though known in the separate state, seems not to possess by itself true epistylic properties. We may call an adjunct which seems thus to be appended, on the outside as it were, to an epistyle, an "exepistyle" (ἔξω, *without*). We shall hereafter see that it is a particular kind of "exepipole:" this new general term will be explained in the sequel.§

ferrare] is a single epistyle, for this molecule takes two proportionals of prostylobase to complete its salts.

* See end of Sec. 6, ch. iii.

† See Journ. Chem. Soc., vol. vii. p. 183.

‡ I have interpreted the formula of the author into the ordinary notation.

§ In the punctuation of formulæ I shall sometimes use a full-stop to indicate the separation and connection between an exepipole and an epipole; especially when the exepipole is not of epipolic form.

obtained mixed with th
$K_2Cy_2.Fe.Cy_2$ to a solu
stable compound is pecu
taining the same molecul
antibasic place; it passe
Oxygen and of other anal
sian Blue, which is proba
same dibasic epistyle; a
again from this compound
(Hydra-Sulfade). I shall h
blue again in considering, i
"Ferricyanides," which ar
as salts of a kind similar to th
as being salts of a polybasic
theory, I should have to rep
nides," which are supposed
form $\left.\begin{matrix} B'' \mid Cy \\ \overline{B' \mid Cy} \\ B \mid Cy \end{matrix}\right\}; Fe_2Cy_3$. H
these salts do not come u
Chapter, as their epistyle Fe
free state.

Section V.

Of the Nomenclature of the Species of Epistyles.

Nomenclature required for epistyles and basistyles.

106. We have now to determine on a form of nomenclature for the distinction of the various species of the epistyle class, and of the basistyles, including the hydrostyles, and among them the acids, of which the epistyles or some of them are constituent parts.

Misapplication of "acid" to certain epistyles.

107. Under the current terminology these epistyles are, as we have observed, termed generically acids, and this term is repeated in the name of each species. Thus C,O_2 and Si,O_3 are called Carbonic and Silicic Acids; and $H:O;C,O_2$ and $H:O;SiO_2$ are called Hydrated Carbonic Acid and Hydrated Silicic Acid respectively. But even if this method were not inadmissible in our system on other grounds which have already been stated, it is quite inapplicable, with any possible meaning of the word "acid," to those epistyles which require, for the completion of their hydrostylic or acid nature, not water, but some other Hydralide.* Thus for instance Pt,Cl_2, "Bichloride of

* To the fact that those of the pseudo-acids or adjuncts which were first known contained Oxygen, as their characteristic Halogen, that element owes its name "Acid-maker." We now know that this property of acid-making is not in any sense confined to Oxygen alone; it belongs to several others of the Halogens in this sense of making adjuncts to styles, and in every sense in which it can be applied to a body occupied on the volta-negative side of salts; and in the sense of forming an acid with Hydrogen, which would be the simplest acceptation for it, it applies per-

(K:O;H,O) be added to
K:Cl:Pt.Cl$_2$. In the pr
cannot be [illegible] O,
here to H, and that Cl
exchange. Now it is not
that the Pt.Cl$_2$ gives it posi
so the new acid could not
Hydrated, and "Hydrochl
long an epithet.

Right use of word "acid" in such cases.

108. But under a system

haps with less propriety to Oxyge
coclassicals the Halogens, since, though
part of an acid, it is amongst the fe
prominent character is by no means
any one property in which Oxygen s
fellow Halogens, it is in giving a po
pounds with the basic metals; with
the attribute of readily exchanging
any other such body that can be t
This character is of course most m
saline attachment for Halogens is t
called Alkalinity: it is due of cours
volta-negative character of Oxygen.
tue of acids consists in their Hydroge
the Halogen may be [illegible]

…being Sulfic Acid, the hypothetical
…und H:S;AsS_5 might be Sulfarsenic Acid,
H:O;SO_3 Oxysulfuric Acid. Again, H:Cy
Cyanic Acid, H_2;Cy_3;Fe,Cy would be Cy-
…rric Acid, H:O;C,O_2 would be Oxycarbonic
and since Carbon is not a Halogen, there
be no place in our nomenclature for "Car-
Acid."

). In each case the name of the acid would Formation of names of acids.
…ience with that of the characteristic Halogen,

…nanageable than they are when in the free condition.
…er vaguely we may interpret the term "acid," one thing
…ays certain about it, namely, that it should denote a body
properties in some way the very opposite of Alkalinity.
I therefore of being named the "acid-former," this ele-
…as much more claim to be considered by speciality the
maker, and would be much more appropriately called
…en."
there is one body which is especially the maker of acids,
Humphry Davy showed, and as has been described in the
this of course is Hydrogen. Whence it appears that in
…nclature founded on properties, H. would appropriately
…

being followed, in case of a complex acid, by th
name of the antibase: we should thus have
method of naming all acids of the second orde
and the same method might be extended to th
insoluble hydro[illegible]by the introduction of th
word [illegible]t among these acids are s
veral [illegible]e formed by combination
[illegible]he same Halogen, with th
[illegible]le. It is absolutely neces
[illegible] differences, but the mod
[illegible] the received nomenclatur
is far [illegible] least irregular part of tha
crude system; I therefore shall make no apolog
for endeavouring to improve upon it. Thus the
$H:O;S,O_2$ must be distinguished from $H:O;S,O$
I consider that the terms Bin-oxy-sulfuric* an
Teroxysulfuric Acids convey a much more precis
notion to the reader than do the terms Hydrate
Sulfurous and Hydrated Sulfuric respectively; an
I think that by applying the same method to th
nomenclature of the oxyacids of Chlorine, whic
form a longer series, we shall obtain names a

* When I have occasion to insert in the name of a compoun
numeral particles to denote the numbers of molecules of a give
kind occurring in the compound, I shall, for the sake of un
formity, adhere to the following rule:—a numeral prefix, bo
rowed from the Latin, will be used when the molecules referre
to are of a stylic or of styloid nature; from the Greek, whe
basic or basoid. By "styloid" and "basoid," I mean respe
tively corresponding, by analogy of chemical position, to style an
to base. The scope of these expressions will be more clearly s
forth in the sequel.

as short and as easy to remember, and to
them to their proper objects as are those
in use. Thus we should have Unoxychloric
ychloric instead of Hydrated Hypochlorous
);ClO), Teroxychloric for Hydrated Chlorous
);Cl,O_3), Quintoxychloric for Hydrated Chloric
);Cl,O_5), Septoxychloric for Hydrated Per-
ic (H:O;Cl,O_7). But these differences in
rical constitution might be more briefly ex-
ed by a simple modification of the special
et.

Epistyles the ground of nomenclature for derivative Acids and Salts.

0. Now the epistyle is the most important of the style in basistyles of this order. It be convenient therefore, first, to determine fic names for the epistyles, and from these to e terms for the acids and salts into whose osition they enter. Rejecting the word acid ogether inapplicable to the epistyles, we might another form of name which has been given to of these bodies. The terms to which I refer st of the name of the antibase in the genitive preceded by a word derived from the name of metastylic halogen, with a prefix indicating the ber of atoms of the latter constituent. Thus I_2 is commonly Bichloride of Platinum, so $—SO_3$ might be termed respectively Binoxide Teroxide of Sulphur, $SiFl_3$ might be Terfluo- of Silicium, Sb,S_5 Quinquesulfide of Anti- ; but short terms are a great comfort in ical language, and these long appellations d not help us at all in making names for the

derivative basistyles. We may easily construct one-worded name for each epistyle, according the same principle we have already applied to t nomenclature of the Halades.

Nucleus of name from antibase.

111. The nucleus of the name should be deriv from that of the antibase or denominator; th may be very conveniently preceded by a syllab representing the metastyle or characteristic.

Equivalents of metastyle marked by vowels.

112. Again, the number of equivalents of th characteristic is of prime importance: as we ha taken the vowel *a* to indicate the unity of th halogen atom in the halades, we may use th series of vowel letters in their usual order in th Latin alphabet to represent severally the num ber of the halogen atoms in the epistyles, taking thus for 1, *a*; 2, *e*; 3, *i*; 4, *o*; 5, *u*; 6=5+1, *au*; 7=4+3, *oi*.*

Epistyles marked by terminal consonants.

113. Next it is important to express the chemi

* *Eu*=2+5=7 would be a fitting substitute in French and German for the English *oi*, to which in the latter language it is nearly equivalent in sound. The principle of word-forming here proposed has already been admirably applied in chemical nomenclature by Laurent, in the cases of the derivative compounds which he derived from Nafthaline by the introduction into it of successive additional atoms of Chlorine, Chlonaftase, Chlonaftese etc. The adaptation of it which I here suggest is only an extension, under slight modification, of the plan accepted by the standard authorities in the construction of such terms as Sulfite and Sulfate, an excellent beginning, at which it is most curious that chemists should have stopped short, preferring to proceed with the clumsy machinery of *per* and *hypo*. If when Lavoisier reformed the nomenclature of chemistry, bringing it up to the condition acquired by the then state of the science, he had happened to propose the termination *ate* for the lower degree of oxidation

on of a compound in its name. As then aken the consonant *d* in the last syllable ades to denote their constitution, we may peculiar consonant to the termination of les. The letter *r*, which in the ordinary ture occurs in the final syllables of several nplex acids which contain these epistyles, ic, Nitric, Phosphoric, Cloric, Telluric, will serve appropriately to characterize nations of our epistyle names. Thus *ar*, , *ur*, *oir*, or, with the mute appendage r orthography affects, *are*, *ere*, *ire*, *ore*, would be the terminal syllables of the epistyles containing 1, 2, 3, 4, 5, 7 of metastyle; the termination *aur* or ably would not occur, as no epistyle is ich has certainly six atoms of metastylic

he higher, the plan which I shall recommend for the alts would probably have been adopted, as a matter soon as the advance of our knowledge required it: alling as it did so as to invert the alphabetic order le, without following their succession, seems to have hint which was involved in his suggestion. Here- ppendix I.) I shall have occasion to refer to a more plication of the same principle proposed by Gmelin, he construction of an entire new chemical nomencla- formation of words in which the vowels and other e terminal syllables, represented numbers, was, I adopted in an admirable little book called Grey's echnics,' published some half or more of a century rpose of the system in that work was chiefly to aid in the retention of dates.

o, though not unknown as a metastyle number, is

Examples of new nomenclature.

114. Thus we should have the new terms which are indicated in the third column of the table on

very rare; even bodies of the form Ab,Ha_4, though not serving as epistyles, are very rare; OsO_4 is almost a solitary instance of quadridactylic epistyle; Sb_2O_4 (Stibore ?) is a doubtful case, being possibly composed of $SbO_3 + SbO_5$; NO_4 again is probably not a true epistyle; SO_4, which we see so often represented in formulæ, has no existence.

It will be convenient to have distinctive names, general and special, to mark compounds which are neither salts nor epipoles, which nevertheless, like NO_4, consist of halogens, combined with molecules which, under other conditions, act as bases or as antibases. I would call such salt-like bodies "Parahales," as being "false salts;" and such as, like NO_4, resemble epistyles in form, I would distinguish as "epistyloid parahales," or briefly "epistyloids." Again, the molecule which in such a parahale corresponds to the base of a salt, or to the antibase of an epistyle, and which may therefore be said to be basoid, I would call the "Pseudobase," and the molecules, which in the same compound correspond to the style of a salt or to the metastyles of an epistyle, and which may therefore be said to be "styloid," I would call "Parastyles:" thus, $As,O,$—Ba,O_2—NO_4, are Parahales, in which respectively As,—Ba, and N are the Pseudobases, and O—O_2 and O_4 are parastyles.

It will be seen hereafter that there are two kinds of parahales, one of which we have here to notice as resembling epistyles, while the other, though closely analogous, approaches to another type. I would distinguish the species of these two kinds from each other, and from the bodies which they most resemble, by forming their names on the same plan with those of their analogues, but with a difference of termination which may indicate the difference in function; I would then construct the names of those parahales which most resemble epistyles according to rules precisely the same as those which I have laid down for the names of the epistyles, substituting for the *r* of the final syllable another liquid consonant *m*: thus, As,O would be Arsename or Arsame; Ba,O_2 Bareme; NO_4 and ClO_4 Nitrome and Chlorome.

Molecules that are neither known to exist as bodies, nor, from

94; in the first and second columns of which
ctively the formulæ and the old names are
ged.

y or from other reason, may be expected to exist, do not,
ive, require names at all; I therefore do not propose to
ny name to the group of atoms SO_4, to which the term
has been applied; all analogy is against the existence of
ylic group as a body. The only two compound styles at
known, C_2N and C_6N_4, are constructed on a model totally
nt from that of the supposed S,O_4 and that of all other
x styles. Again, by far the greater number of those styles
most nearly resemble this $O;S,O_3$ in form, namely those
second order, whose antibases consist of a single elemen-
olecule, contain an epistyle that is known to exist as a very
e and stable substance, without any symptom of a tendency
a free plectostyle. Nay more, as if to guard us against
ing that we had found the complex styles of this type in a
ntive form, those antibases which admit of different degrees
dation often omit the alternate gradations, lest, as it were,
ght imagine that such intermediate compounds were the
lectostyles formed by the addition of one atom of oxygen
epistyle preceding it in the series: thus we have P,O_3
fire), P,O_5 (Phosfure), both epistyles, but no such body
)$_2$ is known. Thus, 3, 5, and 7, being numbers which occur
ee of the metastylic places of epistyles, 4 and 6 are very
r wanting in this position; and when we know two succes-
xides of the same series, such as SO_2—SO_3 (Sulfere and
) and Cl,O_2—Cl,O_4 (Chlorire and Chlorome), the mode
formation of the more complex body is always such as to
us that it is not the style, which the next inferior oxide
, as epistyle, to constitute. There are many epistylic bodies,
, not being true salts, yet much resemble basistyles in their
nction, as being composed of a basic or basoid molecule
d with stylic or styloid molecule or molecules, but not
saline conditions. A general term is required to designate
compounds: the word "Pseudohale" will be appropriate
hem: Sn,Cl_2—Hg,Cl_2—Sb,S_3—Au,S_3 are such pseudo-

Cl,O	Hypochlorous Acid . .	Oxychlorare.
Cl,O_2	Chlorous Acid	Oxychlorire.
S,O_2	Sulfurous Acid . . .	Oxysulfere.
S,O_3	Anhydrous Sulfuric Acid	Oxysulfire.
CO_2	Carbonic Acid	Oxycarbere.
NO_3	Nitrous Acid	Oxynitrire.
NO_5	Anhydrous Nitric Acid .	Oxynitrure.
OsO_4	Osmic Acid	Oxyosmore.
AsO_3	Arsenious Acid . . .	Oxyarsire.
AsO_5	Arsenic Acid	Oxyarsure.
I,O_7	Periodic Acid	Oxyiodoire.
$PtCl_2$	Bichloride of Platinum .	Chloroplatere
$AuBr_3$	Terbromide of Gold . .	Bromaurire.
SbS_5	Pentasulfide of Antimony	Sulfostibure.
$SiFl_3$	Fluosilicic Acid . . .	Fluosilicire.
Fe,Cy	Cyanide of Iron . . .	Cyaferrare.

The prefix *Oxy* may often be dropped.

115. Now, as we have already remarked, by t the greater number of Epistyles have Oxygen t their characteristic Halogen; we may therefc further simplify the terms of most of the epistyl by dropping the prefix *oxy* or *ox*, whenever su omission will not involve any confusion of t oxygen compound, with an epistyle characteriz by another halogen. Thus for the first elev names in the above table may be substituted t simpler terms Chlorare, Chlorire, Sulfere, Sulfi Carbere, Nitrire, Nitrure, Osmore, Arsire, Arsu Iodoire. In the case of epistyles having other cl racteristics, it will be necessary to express them the name; but when no metastylic prefix is used, may be understood that oxygen is the metastyle

As to Epistyles with

116. There are a few instances of epistyles wi

more than one halogen among their metastyles. It will be sufficient in these cases to express both of the metastylic elements in the name, and to denote the number of molecules of one of them by a numerical prefix; the number of the other will be indicated by the difference between that of the prefix and the total number of metastylic molecules denoted by the vowel of the terminal syllable. In such cases also, if oxygen be one of the metastyles, it may be omitted in the name, its presence being inferred as the residual metastyle from the numerical difference between the prefix and the termination: thus we have "sulfoxyphosphoric acid" PO_3S_2; this we may call Bisulfoxyphosfure or Bisulfosfure; the latter name implies that it is a phosfure ($P.O_5$), in which two atoms of Oxygen are substituted by two of Sulfur. Again, "Anhydrous Sulfuretted acetic acid," $C_3H_4O_2S$,* would be trisulfacetire.

several halogen metastyles.

Section VI.

Of the Nomenclature of the Species of Salts having Styles of the Second Group.

117. We have now to determine on a consistent method of nomenclature for the species of the basistyles, including the hydrostyles, and among them the acids belonging to this second group, that is to say, of the epistylobases or salts containing the epistyle which we have been discussing. Under

Nomenclature of basistyles; now incongruous.

* See § 103, p. 79.

the present system there is no regularity in the names of these compounds: those of some are formed on one plan, those of others on another.

Acids,—in *ic* and *ous*, with *hypo*, *per*, and *hyper* prefixed.

118. Those hydrostyles of this group which have Oxygen for their characteristic Halogen are usually called by the term acid, each having an adjective epithet which denotes in a rough manner its composition. In cases where the same antibase occurs in several hydrostyles with different quantities of oxygen, such cognate species are distinguished by the appellative epithets being varied by the terminations *ic* or *ous*, according as there is more or less oxygen present, but without any exact reference to quantity. If more than two distinct species are known having the same antibase, the others are vaguely distinguished by the clumsy prefixes *hypo*, *per*, and *hyper* attached to their epithets. If a student has a clever memory, he can remember, after some years' practice, to which of a set of cognate species the majority of authors apply such terms respectively; but the names cannot remind him of their composition. There cannot be said to be any method of nomenclature applied to these hydrostyles which have not oxygen for their characteristic.

Other basistyles in *ate* and *ite*, corresponding to *ic* and *ous*.

119. The other basistyles of this order, not having Hydrogen for their base, but having metastylic and prostylic oxygen, are supplied with names formed from these names of the corresponding hydrostyles, by the conversion of the *ic* and *ous*, of the last syllables of the acid-epithets, into *ate* and *ite* respec-

tively; the substantive term so formed being prefixed to the name, sometimes of the base of the compound, sometimes of the oxybase: thus we have $Pb:O;S,O_2$ and $Pb:O;SO_3$ called "Sulfite and Sulfate of Lead;" but $Ca:O;S,O_2$ and $Ca:O;S,O_3$ are termed "Sulfite and Sulfate of Lime," not of Calcium. Salts of this order, which are characterized by some other Halogen, not Oxygen, cannot of course have the name of the oxybase involved in their appellations. The names of these are formed sometimes according to the analogy of those of the corresponding Oxygen Salts ending in *ate* or *ite*, sometimes according to that of the current names of the salts of the first order, with the termination *ide*. Thus we have $(Na:S)_3;Sb,S_5$, Sulfantimoniate of Sodium; $(Pb:S)_2;AsS_3$, Sulfarsenite of Lead; $(K:Cy)_2;Fe,Cy$, Ferrocyanide of Potassium; $Ba:F;Si,F_3$, Silicofluoride of Barium; $K:Cl;Pt,Cl_2$, Platinochloride of Potassium: the latter compound has recently been called, in much better style,* "Chlorolatinate of Potassium."

120. Now there is obviously no reason why the names of all these epistylobases should not be constructed on a uniform plan. There is also no reason why, in all ordinary cases, the name of the prostyle, to which the epistyle is attached, should be involved in that of the resulting complex salt. The name of the base, not of the halobase, is the requisite for distinguishing the different salts of the

Epistylobases should be named from metastyles.

* Gmelin's 'Handbook of Chemistry,' Watt's Eng. Tr., vol. vi. p. 322.

same complex style, of which the halogen must b indicated in that part of the name which refers t the style itself; and since, in by far the greate number of instances, the prostyle is the same as th metastyle, the name of the latter will sufficientl mark the former. Again, since Oxygen occurs a the prostyle far more frequently than any othe element, there is less reason than in the case o any other prostyle for inserting its name, in thi sense, in the appellation of the salts which i characterizes. When therefore no syllable occur in the name as expressive of either metastyle or prostyle, it may be understood that Oxygen lies in the prostylic place. We may apply the term "protoxybase" to any oxybase which is considered in reference to the epistyles with which, as a prostylobase, it may combine. From our names then for the epistyles we may very appropriately derive a set of neat terms for our epistylobases. As we have taken the consonant *d* to denote, in the names of our salts having styles of the first group, that their styles are autostyles, we may, again following the custom of the old nomenclature, place a *t* in the terminal syllable of the names of these other salts to signify the peculiar complexity of their styles. Thus we may take the terms epistylate, epistylete, epistylite, etc., to designate generally such epistylobases as contain one, two, three, etc. metastyles, and we may derive the particular names of the various genera and species of these salts directly from that of their epistyles, convert-

ing the *r* of the final syllable of the epistyle-name into a *t*, and retaining the vowel in its final syllable for the indication of the number of molecules of metastylic halogen. Thus we shall have for salts of the following forms, the general names which are annexed to them in the same horizontal line:—

B:O;Cl,O, Chlorates.
B:O;Cl,O_3, Chlorites.
B:O;S,O_2, Sulfetes.
B:O;S,O_3, Sulfites.
B:O;C,O_2, Carbetes.
B:O;N,O_3, Nitrites.
B:O;N,O_5, Nitrutes.
B:O;Os,O_4, Osmotes.
B:O;As,O_3, Arsites.
B:O;As,O_5, Arsutes.
B:O;I,O_7, Iodoites.
B:Cl;Pt,Cl_2, Chloplatinetes.
B:Br;Au,Br_3, Bromaurites.
B:S;Sb,S_5, Sulfostibutes.
B:F;Si,F_3, Fluosilicites.

Specific names of salts,—how to be formed

121. The specific names of the salts of the various bases may be formed of the name of the base in the genitive case, with the generic name of the salt, as derived from its epistyle, prefixed: thus—

K:O;Cl,O, Chlorate of Potassium.
Ca:O;C,O_2, Carbete of Calcium.
Pb:O;S,O_3, Sulfite of Lead.
Na:O;Os,O_4, Osmote of Sodium.
Ni:O;N,O_5, Nitrute of Nickel.

But the names may b
into a single word, thus

Kali-chlorate.
Calci-carbete.
Plumbi-sulfite.
Sodi-osmote.
Nickli-nitrute.

Names of hydrostyles, —how to be formed.

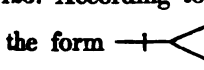
122. The names of
formed on exactly the sa
syllable *hydro* for those
in the above specimen
have—

H:O;Cl,O, Hyc
H:O;S,O_3, Hyd
H:O;N,O_5, Hyc
H:Cl;Pt,Cl_2, Hy
H:F;Si,F_3, Hyd

We are however so much
guishing the hydrostyles
prefixed to the substantive
useful to have a set of sy
principle. Such terms we
epistyles, h

Nitruric hydrostyle.
Chloplatineric hydrostyle.
Fluosiliciric hydrostyle.

For the word hydrostyle of course we may substitute the word acid wherever the body referred to is soluble in water.

123. According to the same method, such salts of the form  , which contain more than one molecule of the same epistyle,* may be distinguished from the simpler salts with a single epistyle, by prefixing a numeral particle to the part of the name that records that member. Since epistyles are neither of styloid nor basoid capacity, I would not take this prefix either from the Latin or from the Greek language; I would take them from a Teutonic source, English or German; let me say English, thus— For salts with several molecules of epistyle,—Teutonic particles.

$Na:O;(Bo,O_3)_2$ { Twi-borite of Sodium, or Sodi-twiborite.

$K:O;(S,O_3)_2$ { Twi-sulfite of Potassium, or Kali-twisulfite.

$K:O;(Sb,O_5)_2$ { Twi-stibute of Potassium, or Kali-twistibute.

The two latter terms may be further shortened into Kali-twisfite and Kali-twisbute, by taking the letters *sf* and *sb* to represent respectively Sulfur and Antimony. So the salts corresponding to $H:O;\left\{\begin{matrix}S,O_3\\ \overline{S,O_2Cl}\end{matrix}\right.$ would be unichlotwisulfites.

* See § 103.

Hypothetical Antibases of the anhydrous "acetic," etc. acids (Acetire, etc.).

130. But the most interesting contributions to our collection of epistyles have been those of the epistyles of "Acetic," "Butyric," "Benzoic," Cumiric, and Salicylic acids, produced by M. Gerhardt,* and of "Valerianic," "Caprylic," and "Pelargonic" acids, by M. Chiozza.† I shall hereafter‡ return, in illustration of another point, to the consideration of the constitution which M. Gerhardt assigns to these compounds; for the present I must state that I consider it quite evident that the bodies which he calls the "anhydrous acetic," etc. etc. "acids," are the true epistyles of the hydrostyles, which are called "Acetic," etc. etc. "acids," and that as such they should have the formulæ, names, symbols, and constitutions indicated in the following table:—

		Having the Antibase—		
C_4H_3,O_3	Acetire . . .	C_4H_3	Acetyle	=Ac.
C_8H_7,O_3	Butire . . .	C_8H_7	Butyle	=Bt.
$C_{10}H_9,O_3$	Valire . . .	$C_{10}H_9$	Valyle	=Vl.
$C_{16}H_{15},O_3$	Caprire . . .	$C_{16}H_{15}$	Capryle	=Cpr.
$C_{18}H_{17},O_3$	Pelargire . .	$C_{18}H_{17}$	Pelargyle	=Plg.§
$C_{14}H_5,O_3$	Benzire . . .	$C_{14}H_5$	Benzyle	=Bz.
$C_{20}H_{11},O_3$	Cumire . . .	$C_{20}H_{11}$	Cumyle	=Cml.

Doubtful composition of anhydrous Salicylic Acid.

131. Of the remaining compound there is, I think, a doubt whether it be a quinquedactylic or a terdactylic epistyle; that is to say, whether it

* Ann. Journ. Chem. Soc., vol. v. pp. 127, 226; and 'Pharmaceutical Journal,' 1853, August, p. 71.

† Ann. Journ. Chem. Soc., vol. vi. p. 184.

‡ See Part II. ch. iii. sec. 9.

§ See note, Part III. ch. ii. sec. 1.

have the same antibase with that of Benzire or one isomeric with Benzyle, or whether it have the antibase $C_{14}H_5O_2$, to be called Salicyle. In the former case it will have to be written $C_{14}H_5,O_5$, with the name Benzure or Salisure; in the latter case it will be $C_{14}H_5O_2,O_3$, with the name Salisire.*

Probable existence of these hypothetical antibases.

132. It must be remembered that the antibases of these epistyles are at present hypothetical molecules, but their existence as bodies is not unlikely. It will be observed that, since we have in these new epistyles the representatives of two, perhaps of three, series of complex hydrostyles, which a short time ago would have been classed in our Third Group, there can be little doubt that the whole of each of these series, one of which at least is very numerous, will have to take their place among our salts of the Second Group with isolable epistyles; but at present the epistyles of the rest of the species of these families are hypothetical. All these epistyles form hydrostyles by combination with water, which is however effected slowly, and seems to require the aid of heat to promote it.

Section VIII.

Of the Relations of Water to certain Acids having Styles of this Group.

Relation of certain complex acids to water.

133. The relation of the complex oxygenous hydrostyles of this group to water is a matter of so

* See note, Part II. ch. iv. sec. 1.

much importance to the theory of Salts, that it will be worth while to devote some little space to its consideration.

Various functions of water in composition.

134. First let us notice the several functions which water fills in composition. Water plays sometimes the part of a simple hydrostyle or acid, sometimes that of a prostylobase, sometimes of an epistyle; it also combines with other single salts to form double and multiple salts; it is also an oxybase, and claims, by its solubility in itself, to be included in our definition of an alkali. Water acts as a simple acid on Calcium; for instance, oxidizing that metal and evolving its own Hydrogen, which is the vehicle by which the Oxygen is brought to the new base. It acts as an alkali on Chloride [Chlorade] of Bismuth, precipitating the metal from solution, in part, as an oxide [oxade]; it acts as a prostylobase to the epistyle S,O_3 in the formation of $H:O;S,O_3$ [Sulfiric Acid]; it seems to act as an epistyle in $Ca:O;H,O$ —$Ni:O;H,O$, etc. and to form, with $Zn:O;S,O_3$ [Zinci-sulfite], a double salt, which I would represent by the formula $\frac{Zn}{H}\Big|\frac{O;S,O_3}{O}$.

Water as mesotype of binary stylobases.

135. The various capabilities of water mark it as the mesotype* of the binary compounds formed

* By a "mesotype" I mean a species which presents the characters of a group in mean degree, combining usually the attributes of many allied forms without exhibiting any of them in peculiar prominence. By a hypotype I shall mean a species which is marked in an inferior degree with the characters of the

by the Stylobase attachment, seeming to combine in itself the functions of all other such compounds. Among epistyles it is hypotypic, or of inferior degree, having for most oxybases but weak epistylic attachment; but among prostylobases it stands pre-eminent as a telotype, forming perhaps of such bodies a vastly greater number than do all other simple, single salts, taken collectively. This obvious and ancient notion of water being the mesotype of a large class of compounds, has recently been put forth by Mr. Williamson* and by M. Charles Gerhardt.† The relation is a most important one; the manner however in which these eminent authors, in pursuance of their peculiar theories of the constitution of chemical compounds, trace this analogy in the case of certain compounds, to which they apply it, seems so contradictory to ascertained fact, that it is necessary to my purpose to mention it. According to those chemists who adopt the notions of M. Gerhardt, water consists, not of $H+O$, but of $H'+H+O$; the equivalent number of Hydrogen, H', being taken to be half that which passes

The "Unitary" Theory.

group to which it is assigned, seeming to approach the members of another group. I shall use the word "telotype" to signify a species which is endowed to the highest extent with the qualities which are characteristic of its group, of which it may be taken, not as a mean, but as a perfect representative. By the word archetype I shall denote the ideal form after which any body or set of bodies is supposed to be formed.

* Qu. Journ. Chem. Soc., vol. iv. p. 352.

† *Ibid.*, vol. v. p. 127.

Oxygen and two volu
assumed that equal v
contain equal number
posed to be the measu
tions. I think that, e
grave objections to thi
it on this ground invo
high a significance to t
haps we may yet disco
state, in which its equ
double of that which it
my object here is not to
others, but to point out
best interpretation of n
facts, which a new and co
tends to explain, are equ
old and simple theory.
to pursue the views of th
generalities, but shall in

* Since H represents that q
bines with Oxygen to form wa
the old notation altogether, ado
the ..."

tail at which I find myself stumbling against

. Now if there is one thing certain in che- The value of voltalysis ignored by "Unitarians."
y, it is that some compounds are decomposed
e voltaic current, and that under voltalysis a
f such bodies appears uniformly at the anode,
volta-negative, and the rest at the cathode,
volta-positive; this is the sole ray of unmis-
le light which yet has reached us amid the
re mysteries of chemical union. To this one
constantly to look with clinging hope, that
y yet help us to a knowledge of the other
concerned in the construction of the more
ex substances; taking care however, mean-
that we do not expect it alone to give us any
information about the consitution of those
on which it manifestly has no bearing.
respect to this one force, we can, in our for-
represent so much of the nature of a large
of compounds as is affected by the stylobasic
ment, and that much is by no means of
lary importance; as to the rest of the or-
tion of the more simple bodies, we can only
suggestions, founded on scattered facts and
nent analogies. But this one spark of vol-
lumination is extinguished, or at least placed
a bushel, by M. Gerhardt's theory. Those
llow or agree with this chemist, ignore the
tion derived from the voltaic pile; while
fall into the opposite error of inferring
ts indications more than it teaches us: thus

both fall into similar mistakes, setting up theo
which are flatly contradicted by the simplest
periments.

Importance of voltalysis within its province.

137. According to the views of the "Unitaria
chemists, Acetic [Acetiric] Acid, for instance
water, in which one of the two proportionals of
drogen is replaced by the group of atoms $C_2H'_3$
water, on this plan, being represented by $\begin{matrix}H'\\H'\end{matrix}\}O$.
Acetic [Acetiric] Acid is written accordi
$C_2H'_3O\}O$.† Now here not only is all sigh
the molecular constitution of water and of
acid, as revealed by the voltaic pile, quite
but the indications of this invaluable dissec
tool are directly contravened; for if the nota
$\begin{matrix}H'\\H'\end{matrix}\}O$ and $C_2H'_3O\}O$ does not mean that
$H'+H'$ are together volta-positive in water,
$C_2H'_3O+H'$ are volta-positive in Acetic Acid
really represents almost nothing at all; for
most important fact we know about the comp
tion of water, is that in it all the H or $H'+H$
volta-positive and all the O negative; and a
mula which does not indicate this, does not n
the most fundamental fact in the nature of
body it depicts; and if this is not meant t
denoted by the formula, it might be as well

* Gerhardt's 'Introduction à l'Étude de la Chimie par le
tème Unitaire' (Paris, 1850).

† Qu. Journ. Chem. Soc., vol. iv. (1851) p. 237, and
(1852) p. 130.

for the sake of symmetry, to write it
[′. I know of no other sense in which the
O can be said to replace the H′, except in
hat it, like the first atom H′, goes to make
: volta-positive member by being added to
:her atom H′; and I know of nothing else
the formula $\left.\begin{matrix}C_2H'_3O\\H'\end{matrix}\right\}O$, as written in pre-
e to $H'OC_2H'_3O$ or to $C_2H'_4O_2$, can be taken
an; and if it means this, it asserts as truth a
profound falsity. If it be said that the for-
loes not notice, and that its advocates do not
iize, the all-importance of the voltaic con-
ion of water, then the latter make, and the
r records, a grievous mistake; for the voltaic
and the binary theory, though of no import,
-alueless as respects bodies not constructed
ling to the laws of this bipolar agency, are
nificant in the case of true voltalytes. To
value knowledge which we have acquired by
' this power, because it does not enlighten us
atters with which it has no concern, is as
losophical as to expect it to explain the na-
of all compounds. It is as grave an error to
s from the attempt to bind protean nature as
o essay to carve its every form to suit a pro-
:an formula.

3. The voltaic pile has dropped almost entirely from the hands of the chemical anatomist. But discovery of capital importance has been made it of late years; so simple, yet so comprehen- Kolbe's voltalysis of Valerianic Acid.

sive in its bearings, that one wonders the experiment was not made long before; nevertheless since its announcement it has almost escaped notice. This is the more surprising to me, as the question was one which, on account of the light which its solution would throw on the theory of Salts, I had noted for examination when the opportunity might offer, long before it was put to nature by hands infinitely better qualified for the task. I allude to Dr. Kolbe's voltalysis of Acetic [Acetiric] Acid of Valerianic [Valiric] Acids,* and to the definite ascertainment, by those experiments, of the cardinal fact, that the Zoogenic molecules of the salts submitted to treatment (the Valerianate of Potassa [Valerite of Potassium] and Acetate of Potassa [Kal-acetite]) belong to the volta-negative side of the compound in each case, and appear among the "anion" bodies at the "anode," against the positive volt-ode of the pile. It was not to obtain information as to this point, the one which I should have first sought and which seems to me the most important one, that Kolbe made this experiment. He entered on the inquiry for the purpose of ascertaining the internal constitution of the Zoogenic group of molecules in these compounds. It seems strange that chemists should be seeking knowledge of the intimate structure of partial members of compounds before they have determined the relative position of these different organs to each other, and their articulation, so to speak, to the main

* Qu. Journ. Chem. Soc., vol. ii. pp. 159, 183 (1849).

body of the compound; nevertheless though this was not the object of Kolbe's inquiry, he did not let the opportunity, of learning this truth by the way, escape him. Accordingly he says: "With a view of ascertaining at which pole each of the products" of the voltalysis "was liberated, I endeavoured to separate the electrodes by means of a porous diaphragm, which allowed me to collect separately the substances disengaged at either pole. . . . It was found that, on closing the circuit, only Hydrogen and free Potash were disengaged at the copper pole; while all the other products, the Ethereal Oil, Carbonic Acid, the Odorous Gas, and the free Acid, appeared at the positive pole."*

Of Acetic Acid.

139. This was the result of an experiment on the Valerianate [Valerite]. Precisely analogous was the answer yielded by the Acetate [Acetite] on being subjected to the question: "Acetic Acid, when decomposed in the circuit of the voltaic current, is decomposed into Methyl and Carbonic Acid, both being liberated at the positive pole, whilst at the negative pole pure Hydrogen alone is evolved."†

* Qu. Journ. Chem. Soc., vol. ii. p. 159.

† Qu. Journ. Chem. Soc., vol. ii. p. 183. The voltalysis of these Zoogenic acids is obviously a phenomenon precisely similar in its first stage to the similar decomposition of Hydrated-Sulfuric [Sulfiric] Acid. Under the voltaic current the latter compound ($H:O;S,O_3$) is resolved into H, which escapes at the cathode; and $O;S,O_3$, which, passing to the anode, either combines with another base, if one be presented to it, or resolves itself into Oxygen, which escapes; and S,O_3, which adheres to a fresh molecule of H:O, or, according to the strength of the solu-

The bearing of these experiments neglected.

140. Here was a bright clear fact, worth, I co
ceive, much more than the arithmetical analysis
the substances and the knowledge of the percentag
of each element contained in them; yet the distin
guished author of the paper to which I refer onl
mentions it incidentally, and makes no commen
upon the highly instructive phenomenon which h
has occasion to notice. All his attention was s
keenly directed to the minute anatomy of the An
tibase part of the acid, that he seemed not to b
aware of the important revelation he was makin
of the general plan of the structure of the entir
compound.* So little notice indeed has been taken

tion, itself suffers decomposition, under the action of the Oxyge
evolved in contact with it. Kolbe represents the Voltalytic fissio
of Valerianic [Valiric] Acid by this equation,—

$$H:O;(C_2.H,(C_2H_2)_4)O_3=\{H\}+\{H,(C_2H_2)_4+2(CO_2)\},$$

of which I have ventured slightly to modify the form, chiefly b
punctuation, with a view to perspicuity, and by indicating wha
I conceive to be the constitution of his hydrocarbon "radical
Valyl (C_5H_9). The final result in this case differs in characte
from that obtained from $H:O;S,O_3$, by reason of the complexity
and instability of the antibase, and the great tendency to the for
mation of the very permanent compound CO_2 [Carbere] wher
ever the disposition of the constituent elements is favourable t
its appearance. The ultimate compounds yielded at the anod
would probably depend on the concentration of the liquid. Thes
experiments of Kolbe's, being more special than the first trial
made by Faraday of the voltalytic behaviour of Acetic [Acetiric]
Acid, as part of a more extended inquiry (Researches in Elec
tricity, §§ 749, 773, 774), must be taken as more precise in thei
results, which however tend entirely in confirmation of the fact
discovered by the great physicist of England.

* Since this was written, Dr. Kolbe has published a pape
(Qu. Journ. Chem. Soc., vol. vii. p. 111) having the same ob

only by Kolbe himself, but by other chemists, :he fact which was thus ascertained, that Messrs. azier and Gosslethi, following up his researches some similar experiments on Caproic [Hirciric] l Œnanthylic [Œnanthiric] Acids, make no ntion in their published account* of their results the voltaic position which the Zoogenic products umed in the decomposition, though there can be doubt that these followed the same law which vailed in Kolbe's experiments. These gentle- n generalize the indications of the results ob- ned by Kolbe and by themselves, to the effect hat the members of the series $C_nH_nO_4$, when ated with the galvanic current, invariably give e to the formation of a hydrocarbon, closely con- ted with the series following, one step lower the scale of organic compounds, Hydrogen and rbonic Acid being simultaneously eliminated." t not a word is said of the far more signifi- nt fact, that the hydrocarbon comes off, as it no ubt did in these latter experiments as well as the former, on the stylic side of the system. hen those who accept a theory do not see the port of a fact which proves this truth, it is not narvel that the fact is ignored by the upholders an opposite view.

with these paragraphs, in which he shows the important ring of his experiments upon the constitution of the salts ich were the subjects of them, and applied his facts to refuta- n of the Unitary Theory. (See a note to the Preface.)

* Qu. Journ. Chem. Soc., vol. iii. pp. 222, 229.

The constitution of Zoogenic compounds defined by them.

141. Now this single term "positive pole," d
fining the place taken by the hydrocarbon on t
voltalysis of a Zoogenic compound, teaches us i
finitely more about the constitution of such a bo
than do whole chapters of discussion about the n
ture of the "radical" which is involved in it.
reveals to us, not, be it observed, that the hydroca
bon is volta-negative, but that it formed part of
complex volta-negative member, which, on the a
tachment which held it to the base being neutra
ized by the opposite induction of the pile, splits u
into subordinate groups, which we may or may n
conceive to have pre-existed in the salt.

The binary theory alone tenable as to Acetic Acid.

142. Now if these acids are to be compared wi
water, as they unquestionably should be, bei
analogous to that liquid in their general chemic
attributes, then previously to this demonstratio
by Kolbe, of the constitution of Acetic Acid, thr
theories might have been held as respects the p
sition of its hydrocarbon member: namely, th
(1) the hydrocarbon is conjugated to the Oxyge
of the nuclear or prostylobasic water; (2) the h
drocarbon is conjugated to the Hydrogen of suc
water; (3) (since the Unitarian suggestion of t
basic part of water not being a unit, but a duad
the hydrocarbon replaces half the Hydrogen, occu
pying in the compound a similar position to t
H′ so substituted. As no one has yet proposed
halve or to double the Oxygen of water, the po
sible fourth alternative, of a part of that memb
being replaced, needs not to be stated; but sin

xperiment of Kolbe, only one of these notions able: for its results teach us unequivocally n Acetic [Acetiric] Acid, and in its similars, ydrocarbons lie voltaically on the same side e compound as does the Oxygen of water. g, in short, a colon to represent the partition bipolar compound into its two members, or, linately, the union of these two, voltalysis us that water is H:O, and that Acetic iric] Acid is $H:O_4(C_4H_3)$, and distinctly $(C_4H_3)H:O_4$, nor $(C_4H_3O_2);H:O$, nor $_3O)H':O$, nor, as the "Unitarians" prefer ite it, giving a precision to their flat contra- n of nature, $\left.\begin{matrix}C_2H'_3O\\H'\end{matrix}\right\}O$. If this acid were logous with the simple salt, water, and if nolecule $C_4H_3O_2$ or $C_2H'_3O$ occupied the position in the acid that H′ does in water, st formula in the preceding sentence would nly be the simplest way of representing the tution of the Acid; but the voltalysis de- trates that this is not the fact, but that (C_4H_3) is the only one of the suggested for- which is not in direct contradiction to the This formula however is not the best that e in a condition to propose for it: it is true as it goes, but does not state all that we are ed to predicate as being known of the consti- of the compound. This acid is certainly gous to water, and it is almost assuredly ana- to Sulfuric [Sulfiric] Acid ($H:O;S,O_3$). On

that is to say, as water $(C_4H_3)O_3$ is associated gen of the halobase w already mentioned,* ar to prove, Gerhardt has pound, this very episty logous in function to S

Synthesis of the Anti-base. The Elæogenous series.

143. But again, as I pursue our theoretical by extending the same governs the constructic our acid, to the synthes on which its epistyle is to justify this explanatic of these zoogenic nuclei. the results of the voltal record. Were this acid voltaic analysis, there ca Carbon would come off tion with Oxygen. We cluding that the constru precisely analogous to th

Now Acetic [Acetiric] Acid is one of a series* of homologous acids, of which each differs from that next below it in order of complexity by the regular excess of two equivalents of Carbon and two of Hydrogen (C_2H_2). The first of these is Formic, of which the most reasonable account that we can render as to its constitution, is that it is—

$$H:O;(C_2,H),O_3.$$

Here C_2H seems to occupy the same position which C_2 holds in Oxalic Acid; the former molecule seems to consist of the latter (C_2), with the adjunct H. conjugated to it. The next step in complexity in this series is Acetic [Acetiric] Acid, the constitution of which is the same as that of Formic Acid, except that here we have C_2H_3 instead of H. Now we can give no much simpler expression of the constitution of this C_2H_3 than that which we obtain by supposing it to be formed by the same process of conjugation which we find occurring in so many other parts of the anatomy of Zoogenic

* The series is commonly called that of the fatty acids, from the mesotypic members of the series. The hypotypic members are soluble in water, aqueous, not fatty. The telotypic species, those in which occur the peculiar properties, to develope which seems to be the aim of the series, are more strongly marked, are waxy, not fatty. Since the best definition of an oil, a liquid, or liquefiable compound insoluble in water, includes two of these types, the fatty and the waxy, the mesotypic and the telotypic, the mean and the perfect, the word "oil" may be taken as the best guide to a name for the whole family; hence the term "Elæogenous," of Greek derivation, would be a suitable general appellation, including them all, since all either form or tend to the formation of oils.

that these compounds correspond to water in form, but have the two volumes of the Hydrogen thereof each replaced by one of the complex carbon-containing molecules. It is also just to the Unitarians to admit that the formulæ which they obtain for their particular compounds, according to their views, involve lower numbers than do those derived from the binary theory, which assumes that the hydrogen of water is a unit. Occasional simplicity however must not be courted to the neglect of constant truth. Now with respect to the constitution of these double compounds, we have no information as to the kind of forces which unite the molecules of Oxygen to the hydrocarbon members. M. Gerhardt would write, for example, the double compound produced from the "Benzoic Chloride" and the cuminate as $\left.\begin{matrix} C_7H'_5O \\ C_{10}H'_{11}O \end{matrix}\right\}O$, and water as $\left.\begin{matrix} H' \\ H' \end{matrix}\right\}O$, and would assert, if this formula means anything, that the same kind of force which unites the basic Hydrogen to the Oxygen of water here unites the two left-hand members, being positive to the one molecule of negative O at the right. If he had demonstrated this point, his position would then have been tenable, but there is no indication of such a condition; on the contrary, we are all but positively certain that in the original compound the "cuminate," of which this new body is supposed to retain the form, the whole of that member of it, $(C_{10}H'_{11}O)O$, which remains in the new body, did not occupy that position, but was

Thus we should represent our acid as—

$$H:O;(C_2-H-C_2H_2),O_3,$$

in which the Antibase is $C_2-H-C_2H_3$*$=$Acetyle.

144. The series of Elæogenous hydrostyles is continued by the successive addition of one more molecule of C_2H_2 to each following species; the next or third term of the series is Propionic Acid$=H:O;(C_2\cdot H,(C_2H_2)_2)O_3$ [Propiric-hydrostyle]. Among the succeeding members are several of which Gerhardt has separated the epistyles; and the two highest at present known are Brodie's— The Elæogenous series continued.

though not known as so decided a base, takes the same position which Ethyl may occupy in certain other important compounds; it is therefore not improbable that Fenyle exists thus conjugated to C_2 in the Antibase of Benzoic Acid [Hydrobenzute], Benzyle, which would then be written $C_2\cdot C_{12}H_5$, or $C_2\cdot H,(C_2)_4(C_2H_2)_2$; so that the formula of this acid becomes $H:O;(C_2Fn)O_3$; so it is probable, on the same grounds, that in the other acids of this Aromagenous series the Antibases consist of basic molecules conjugated to C_2. We should suppose then, on this view that in these cases a certain quantity of the Carbon is polymerized in the original hydrocarbon nucleus, before uniting with the particular single molecule C_2 to which we should attribute the Antibasic character of the complete hydrocarbon group.

* It will be observed that this complex Antibase consists of three members analogous in position to those of the complex Style of an acid of our second order; this resemblance may serve as an aid to the memory in reconstructing the formulæ of analogous compounds. C_2 corresponds to the original Prostyle of the prostylobase; H to the Antibase or Copula (see § 88, p. 73); C_2H_2 to the Characteristic. This analogy however is only formal and superficial, and must not be mistaken for an intimate similarity of constitution.

body, if it be an element or a dimeric condition of a compound, with, in either case, a doubled equivalent weight.* And so we might expect to go on, by successive reduplications, increasing the combining weight of the molecule up to the *n*th power of 2. The cases in which this agglomeration of molecules occurs are rare, and we have no reason for supposing that this is one of them; on the contrary, one of M. Gerhardt's new results is most easily explained by supposing that in one case, even when the molecules thus presented to each other were different, they did not cohere, but that a considerable quantity at least of one of them remained free. I have before alluded to his experiment of the action of "Benzoic Chloride" [Chlo-benzine] on Acetate of Potassa [Kal-acetite]. If this cou-

* Mr. Brodie's facts as to the condition of elements at the moment of chemical change, and his theoretical suggestions as to the synthesis (see Brodie's Essay on this subject, 'Philosophical Transactions,' 1850, part ii. p. 767), must not be supposed to confirm the notion of the coalescence of similar nascent molecules into a compound molecule: his highly interesting views throw no light upon this question. If such a duplication of the elements, as he conceives, does occur, it is not a permanent condition which subsequently belongs to them in their free state, still less does it follow these bodies into their subsequent compounds; for in cases in which two previously free elements unite, without the polarizing aid of a third body, we do not find the ordinary elements after such separation and synthesis entering with doubled equivalent weights into the new compounds they may form. It is most likely that under the Zooplastic forces of the vegetal world this synthesis really takes place, and that we owe the formation of for instance C_2, which seems to play the part of an element in this branch of chemistry, to the simultane-

ere, on the inside both of any theory as to the bstract existence of the "radical" Acetyle (C_4H_3) r Methyle (C_2H_3) in this acid, and of the actual extrication therefrom of either of them in the concrete.

146. But to return to the question of the position of the hydrocarbon, voltaically, in the acid, and to the bearing of this fact on Gerhardt's formulæ. It is possible that some "unitarian," misconceiving the point at issue, may state that it is a well-known fact that voltanegative molecules may replace positive elements without destroying the type of the compound, and that so, though in the voltalysis of, for instance, Valerianic [Valiric] Acid, $H:O;(C_2{\cdot}H,(C_2H_2)_4)O_3$, the hydrocarbon part should come off at the anode by reason of its voltanegative nature, it may nevertheless replace positive H′ in the compound. Let it therefore be well understood, that plain as the voltaic pile speaks, it gives not a hint about any hydrocarbon group, such as $C_2{\cdot}H,(C_2H_3)_4$ or $H,(C_2H_2)_4$, or any other herein concerned, being of itself voltanegative. All it asserts, and that it maintains most unmistakeably, is that in these acids the Zoogen molecule lies on the side contrary to that which the H or H'_2 of water occupies, and that, together with other molecules, it makes up the voltanegative member; so that, whether the Zoogenic group be by itself voltanegative or voltapositive,—and we have no reason for believing that it is in either condition,—it certainly was neither

The Zoogen molecule voltapolar to the Hydrogen of water.

ferent types, one to that of the Elæogenous, the other to that of Aromagenous acids. The duplication of this one body, the carbonous group, derived from Acetic [Acetiric] Acid, as represented in M. Gerhardt's formula, is in this case, whatever it may be in any other instance, purely gratuitous, so far as the facts are concerned, though almost necessitated by the nature of the symbols which he uses. Not the slightest indication is given of a reason why the volatile product obtained in this reaction should not be described as $C_4H_3O_3$. This is what we are fully entitled to consider it to be; and in this case, be it observed, and in those of all the "anhydrous acids," the advantage of simplicity is on the side of the old notation, for the number of elementary atoms, supposed to be involved in the compound in the latter formula, is less by three, and the number of symbols employed is less by one-half, than those of the formula of the new system. In this case then we are fairly entitled to accept the beautiful substance presented to us by M. Gerhardt as truly the epistyle [Acetire] $C_4H_3O_3$ or $\left(C_2 \cdot H, (C_2H_2)\right), O_3$ of Acetic [Acetiric] Acid; and by inference from this case, in the absence of any proof or argument to the contrary in the other cases, we may acknowledge that we owe to him the discovery of the epistyles, of which a list has been given above.

Further experiments wanted on these compounds.

156. But some experiments are wanting to throw further light on the constitution of those of the new "anhydrous acids" which really are coupled.

Can, for instance, the double compound, consisting of the epistyles of Benzoic [Benziric] and Cuminic [Cumiric] Acids, be converted by the action of water into a coupled acid containing both hydrocarbons? if so, it would further demonstrate that this body is not an analogue of water, having its two halves of hydrogen severally substituted; for whether the resulting compound should contain one or two molecules of water, so as to require to be written with the usual symbols, as $H:O;\begin{cases}C_{14}H_5O_3\\C_{20}H_{11}O_3\end{cases}$ or as $\begin{matrix}H\\H\end{matrix}\Big\}\begin{matrix}OC_{14}H_5O_3\\OC_{20}H_{11}O_3\end{matrix}$, it could only be considered as water with the complex molecule annexed to its oxygen. Again, perhaps from one of Gerhardt's double compounds there could be formed a body containing Cl instead of O, and to be represented as, for instance, $\begin{matrix}C_7H'_5O\\C_2H'_3O\end{matrix}\Big\}Cl'$ or $\frac{C_{14}H_5,O_2Cl}{C_2H_3,O_2Cl}$. The action of such a body on the Sodium Salts concerned in the experiments above cited would yield very interesting results; it would perhaps generate for us bodies analogous to Gerhardt's double compounds, but of higher complexity.

The error in this theory.

157. It is somewhat remarkable that these results should be accepted by any chemists as being corroborative of the duad condition of the Hydrogen of water. In reality the duad form of those of M. Gerhardt's compounds which really have this quality, as well of Mr. Williamson's double ethers, to which I shall hereafter refer,* is due

* See Part III. ch. ii. sec. 2.

not to the duality of the hydrogen of water, but to the duality of water itself and of its analogues the salts, as respects their volta-positive and negative members. This fundamental duality is ignored and altogether put out of sight by the advocates of the Unitarian Theory, and in its place is set up a hypothetical duality, attributed to a different law, but owing the sole support which it receives, by lateral assistance, to the very fact which it supplants. The duality of the Soda Salts concerned in these reactions is unquestionable: it is demonstrable that all their metal lies on one side voltaically and all the rest of their constituents on the other, just as all the Hydrogen of water is positive and all its Oxygen negative. It is a perversion of fact to shift this bipolarity by a kind of chemical synecdoche, or figure of theory, from the whole to the part, from the salt to its base. The duality of the coupled compounds actually produced arises further from the dual nature of the experiment: two bodies are brought together, and a two-membered body is the result of the lateral attachment of the two bodies produced by the double decomposition. No such phenomenon ought to be taken as giving even a hint of any fundamental duality, until triple, quadruple, and other experiments had been tried, in which three and other numbers of compounds were simultaneously brought together, with a constant production of only coupled compounds, to the continual exclusion of all triple and quadruple results. Such

mode of proceeding would have excluded the speculative shifting of the true polarity of salts from the centre to the side of their construction.

158. We are still then entitled to consider all true single hydrostyles as waters in which not one-half of the Hydrogen is replaced by another atom, but in which the whole of the Oxygen is either replaced by another molecule, simple or complex, or has conjugated to it another molecule of complex constitution. The correct view.

Section X.

Of the relation of certain Double Salts, having Simple Styles, to the Single Salts having Double Styles.

159. Among the saline compounds of which water forms a part, I have mentioned Double Salts as an important class. To some of the bodies that may be ranged under this head there is attached a peculiar interest, which arises out of an obscurity as to the real nature of some of them, as regards the position which is occupied in their constitution by the water they contain. Obscure nature of some Double Salts.

160. Our idea of a double salt is that of a twin compound, consisting of two single salts linked together in parallel positions, with their neutral points side by side. To exhibit this by a diagram: as we represent a single simple salt by the symbol —+—, two such lines will represent a Ambiguity arising from resemblance of some halogen radicals to Salts.

treatment, their reasoning is effectually vitiated at this its very outset. No argument whatever has been produced, on the occasion of these experiments, to show that Benzoic [Benziric] Acid is not $H:O;(C_{14}H_5),O_3$, that is to say, water in which the complex molecule $(C_{14}H_5),O_3$ is annexed to its prostylic Oxygen; therefore we are still at liberty to maintain that these formulæ are reasonable ones, and to use either of them in representing the changes which ensue in these reactions. We may then represent the formation of "anhydrous Benzoic Acid" thus—

$$Na:O;(C_{14}H_5),O_3+(C_{14}H_5),O_2Cl=Na:Cl+2((C_{14}H_5)O_3).$$

This indicates that for each molecule of Na:Cl [Sodichlorade] that is produced, two separate equivalents of the epistyle $C_{14}H_5,O_3$, Benzire, are liberated. But M. Gerhardt's formula for the resulting Zoogenic compound is $\left.\begin{matrix}C_7H'_5O\\C_7H'_5O\end{matrix}\right\}O$; and if this be translated from unitary symbols directly into the ordinary notation, which he is entitled to claim, we have, instead of it, this formula $\frac{C_{14}H_5O_2,O}{C_{14}H_5O_2,O}$, a double compound analogous to a double salt. Now it is this duplication of the compound which is implied in the unitary formula that is supposed to be proved, and the establishment of which, apart from the Unitary Theory, is strongly suggestive of error in the old theory of the construction of this and of a vast number of other acids.

The coupling of the mole-

153. It is from this supposed coupling of the

ules that the support lent by these experi- to the new theory is derived. It is impor- hen to examine what are the actual results ed in this direction, that due importance e assigned to whatever they prove. If how- ve find that there is no evidence of this ng of the molecules in these particular in- s, and that in the cases in which it does it is due not to the general model of the unds into which these molecules are cast, the special form of the particular experi- , and if, further, we find that the apparent g of the formulæ of the compounds in ques- into the duad figure is owing to the ma- ry of the very theory which is used to ac- t for the change, and which the reaction so ined is supposed in its turn to illustrate, in case we need not yet surrender to the new y the tottering ruins of the old one, but may in for the present tranquilly in possession.

cules the point at issue.

4. The facts which are supposed to demon- e the duplication of the molecules in these ounds are these:—M. Gerhardt found that, resenting the "Benzoic Chloride" to salicy- cuminate, and cinnamate of Potassa [sali- , cumite, and cinnamite of Potassium], com- ds of an undoubtedly coupled nature were ced, containing the hydrocarbon molecules th compounds. He infers, from the double e of these compounds, and from the, to him, ently double nature of the hydrogen of water,

Facts supposed to demonstrate it.

learn, as is perhaps the truth, that in passing to the position of an epistyle, it undergoes a constitutional change, which alters the nature of the polar relation between its proximate molecules. If then we met with a monobasic salt of this or of any similar epistyle, we might represent it by the figure —+— —+—; but to avoid confusion, it would be better to draw it thus —+— —⁄.

2nd, Possible non-coincidence of neutral points of component monohales.

163. On the other hand, as to many substances which we are compelled to class as double salts, from the fact that they are certainly formed of two proximate molecules, each of which is a true simple salt, we are not in every case certain that the basic and stylic members of each component occupy respectively exactly similar positions in the double salts. That is to say, it may be that in such diplohales the neutral points of the component monohales do not coincide; so that perhaps the neutral axis of the complete compound ought not to be represented in our diagram as being at right angles to the direction of the voltaic force. Thus there may be double salts which, instead of being delineated as  , would be more truly described by one of the figures  ,  ,  ,  , or even perhaps by —+— —+—. In these figures the coupling axis, which would be the line joining the neutral points, becomes successively more and more oblique to the line of stylobasic attachment, till at last it coincides therewith in direction, coming to be in the same straight line.

164. All of these forms are included in our rimary notion of a multiple salt, which only sup- oses that the several single salts lying on their nes of stylobasic attachment are disposed paral- l to each other.* Primary notion of polyhale,—parallelism of component monohales.

165. The last of our diagrams, it will be ob- erved, represents a single complex salt, having a rue salt for its epistyle. We thus arrive, in fact, y developing our notion of a double salt, at the ame form that we reached in the other direction, s a possible case, by generalizing our idea of a omplex salt.

166. This then is the loophole for ambiguity. he doubt is, Do double salts pass into single com- lex salts by gradations of form, so that ultimately substance entitled to hold place as a true salt, ven as prostylobase, becomes degraded to the posi- ion of an epistyle? The steps of such a transi- ion may be imagined by conceiving two magnet ars, one much weaker than the other, to be placed ide by side, with their neutral axes coinciding, nd then the weaker to be gradually slid along the tronger, from S. to N., till its S. end slips over the N. end of the other, and the two become converted nto a single magnet, in which there is only a ingle system of magnetic induction and a single eutral point of balanced forces. The analogy is ot perfect, though very close; for in the case of he magnets the neutral point will be shifted to a reater or less distance lengthwise, the more nearly Illustration of the passage of double into single complex Salts.

* See § 64, p. 53.

the two magnets are similar in power, and may be made to occupy any place in the system by varying the force of the second magnet; but in our true single salt, with complex style, we must suppose that the neutral point remains unmoved, always between the Base and the style of the prostylobasic salt. We may conceive it possible that the neutral point of the entire salt may be so shifted by the induction as to pass completely by a step over one molecule of style or Base, but it cannot be imagined to divide either of these into two portions, as it would if it passed imperceptibly from one position to another.*

Diagrammatic representation of this result.

167. We may therefore give a greater precision to our diagram for a double salt, in which one of the monohales has become epistylic, by lengthening the crosslet which represents the voltaic bisection of the prostylobasic salt, and consequently of the entire compound, thus —|— —|—. This figure serves to denote the intensification of the stylobasic

* The position of the volta-neutral point has been very commonly assumed by chemists to have been shifted, in cases where there is no proof of such a change having taken place or even being possible; for instance, in Sulphate of Potassa [Sulfite of Potassium] it is sometimes supposed that the prostylobase Oxide of Potassium (K:O) is volta-positive to the epistyle S,O_3, so that the salt should be written $K,O:S,O_3$ instead of $K:O;SO_3$. No sound reason can be urged in support of this view: it is a mere assumption of the same nature as another, which is sometimes made to the effect that the O_3 in SO_3 is volta-negative to the S: there being no reason for supposing that the voltaic or Stylobasic force plays any part in the structure of the complete salt $K:O,S,O_3$, except between the K and the O.

energy which usually accompanies the complication of either pole of a salt.

168. Noticing the fact that Bases differ from each other very much in their degrees of Basicity, and that Antibases exhibit intensities of energy equally various as compared with each other, and that these two classes of bodies even pass into each other by easy gradations of species, we shall consider it not unlikely that the class of double simple salts, containing two bases, may pass through certain doubtful species into the class of single complex salts with one base and one Antibase. If now we entertain the conception that the more the basic property is weakened in, and the Antibasic nature approached by any given base, so in double salts the salts of such base tend the more to assume the position of epistyles, we shall arrive at a logical modification of our diagrammatic representation of double simple salts. We shall shift the lower line representing the less prostylobasic salt, that is to say, the salt containing the less basic Base, a certain distance to the right, according to our notion of the degree of its inferiority as a base. Having no very exact measure as yet of the degrees of positive energy enjoyed by bases, we cannot give much angular precision to our geometrical indication. As an example of what I mean, let us instance the double Cyanide of Potassium and Silver. Silver is a true base, analogous to Potassium, but greatly inferior to it in positive energy. The Cyanide [Cyade] of silver forms a double salt with

Instances of Salts of doubtful constitution.

Cyanide [Cyade] of Potassium, a solution of which salt dissolves the former just as a solution of the Oxide [Oxade] of Potassium will dissolve the "Binoxide of Tin" [Stannere]. The salt of silver seems here to approach very nearly to the condition of an epistyle; this I would indicate by writing the salt as $\frac{K:Cy}{Ag:Cy}$ $\dashv\!\vdash$. We cannot write it K:Cy;Ag,Cy, $\dashv\!\vdash\ \dashv\!\vdash$, because neither Ag nor the metals most nearly allied to it have any marked antibasic tendency when combined with other Halogens; and when this double salt is submitted to the voltaic current, the Ag appears at the Cathode on the positive side, which is not the case with the Antibases of the true complex "Cyanides." There may be other cases in which we may be disposed to place the two salts in the position $\dashv\!\vdash\ \dashv\!\vdash$. Thus Aluminium is a base in which the positive quality is decidedly weak: Davy did not succeed in voltalyzing its "Oxide," though by analogy we are entitled, I think, to consider this oxide [oxade] a salt analogous to Oxide of Calcium [Calc-oxade]. This "oxide" dissolves however in solution of Potassa, playing in this action the part of an epistyle, as all analogy would lead us to infer; and some metals which are nearly allied to Aluminium are decided Antibases. The metallic compound in this solution then we should write K:O;Al′,O.*

* Alumina is commonly represented as Al_2O_3. My reasons for preferring to consider the quantity of matter so represented

169. Thus then we may have double simple salts of the form —|— —|—, that is to say, double salts, in which both the component salts are simple, the second of them playing the part of an epistyle. Again, a single salt with a complex style (—|— —<) is in every respect analogous to a simple salt, except in the complexity of its style. The component monohales therefore of double salts may be either simple, as in $\frac{Na}{Ag}\vdots\frac{Cl}{Cl'}$, already mentioned,* or complex, as in $\frac{K}{H}\vdots\frac{O;C_2,O_3}{O:C_2,O_3}$, these two salts being respectively of the forms —|— —|— and —|— —<. It becomes then a question whether complex salts too, whose bases have inferior positive power, may not in double salts occupy a position such that the coupling axis should not be drawn rectangularly to the line of stylobasic attachment, but inclined to it at some other angle, thus, —|— —< / —|— —<.

Do complex Salts ever act as halogen radicals?

as $(Al'O)_2$ will be stated hereafter (see note to Part III. ch. v. sec. 7, div. 1, subdiv. 1). On these grounds I would write one proportional of the oxide Al'O. Since in the solution mentioned in the text we are not always certain how many equivalents of the Alumina are taken up, I write in this case the symbol Al'O in the singular number. Of course the accent over the Al' is only intended to indicate that this metal is taken as having an equivalent value different from (namely two-thirds of) that assigned to it under the accepted symbol Al.

* See § 64, p. 55.

Other compounds with ep-epistyles.

§ 3. To the class of systems containing ep-epi- s, we may perhaps refer some of the com- ds formed by the action of $H:O;S,O_3$ on cer- carbonous substances. The acid thus formed Nafthaline ($C_{20}H_8$) i stated to be of the form $H:O;S_2,O_5.C_{20}H_8$. e should be a doubt how- ever about this formu s most of the compounds formed in a similar r er contain, on their stylic side, one atom of F han the compound that is thus annexed to l. Possibly the remark- able acids produced lbe from the Bisulfide of Carbon, CS_2 [Sulfocarbere], may be included under this head; thus:—

$$H:O;S_2,O_5.C_2Cl_3$$
$$H:O;S_2,O_5.C_2HCl_2$$
$$H:O;S_2,O_5.C_2H_2Cl$$
$$H:O;S_2,O_5.C_2H_3.$$

And it would seem that certain acids, formed by the action of SO_3, Sulfire, on C_4H_4, Olefiant gas, and on Ether and Alcohol, have a similar constitution, namely "Methionic Acid," $H:O;S_2O_5.C_2H_3O_2$, and

volving the same antibase with Acetic [Acetiric] Acid, with five metastylic places instead of three (see note to § 185, p. 165). There is yet another possible constitution of these acids which analogy might lead us to entertain, namely that which would represent them as having antibases containing O_2 added to the antibases of Propionic and Acetic Acids; thus, $H:O;C_6H_5O_2,O_3$ and $H:O;C_4H_3O_2,O_3$. Such is the relation which we may suppose Salycilic Acid bears to Benzoic Acid (see note to § 188, p. 166). We should, under this view, say that their antibases were Lactyle ($C_6H_5O_2$) and Glycyle ($C_4H_3O_2$), with epistyles Lactire ($C_6H_5O_2,O_3$) and Glycire ($C_4H_3O_2,O_3$), and we should call the acids themselves Lactiric and Glyciric.

molecule of monobasic epistyle is attached; the second formula is analogous to that of the Ferrocyanide [Cyano-ferrate] of Potassium and Iron, $\frac{K}{Fe}\frac{Cy}{Cy}$;Fe,Cy, not in the construction of the style,* but in that a part of the second salt is represented as being prostylobasic and a part as being in the place of an epistyle. It is not likely that many salts of this form () are to be found, for exactly in proportion as the Basic power is weakened and the Antibasic attachment appears in any given metal, so is its capacity feeble for forming salts with complex styles of the first degree; so that if there is not a tendency to the formation of such salts, these latter cannot themselves be very ready to enter into further combination. Thus Oxide [Oxade] of Antimony, Sb:O, is a very weak prostylobase; it is in fact also an epistyle, lying on the verge between the two forms. It does take up the epistyle SO_3, but there is a want of definiteness about the compounds which it so forms. No distinctly crystalline salt, Sb:O;S,O_3, is known; so here is a reason *à fortiori* why, though we have K:O;Sb,O, we are not likely to be able to form such a single

* The Ferrocyanides [Cyano-ferrates] are of a different degree (a step lower in complexity), for the simple cyanides have a compound style, not a complex one, with an epistyle; therefore the styles of the complex "cyanides" are not doubly complex, since complication, in the sense in which we here use it, commences with the formation of these salts [such as the Cyano-ferrates] themselves. Cyano-metallates not doubling complex salts.

salt as $K:O;S,O_3.Sb:O;SO_3$, with $Sb:O;S,O_3$ as an epistyle. That the further development of this process of complication in salts is thus checked by the results of the very law according to which it may be supposed to be commenced, is, I think, rather a reason to expect that it would occur as an indication of the natural limits of construction in the instances which would seem to be permitted by this law.

Doubtful position of water in "Hydrated Oxides."

171. Now the occurrence of this doubt with respect to the true position to be assigned to the second member of a double salt, namely, to that which contains the weaker Base, is of some importance in its bearing upon one view of the part which water plays in certain compounds. Water, we have said, is the mesotype of all salts, and may occur in any position which any true salt can occupy; it is the prostylobase of all those complex hydrostyles of whose style Oxygen is the characteristic. Does it take the function of epistyle in the compounds which it forms with the oxides of the Basic metals? Are we to write the compounds of the Oxides of Potassium, and of Calcium, for instance, as $K:O;H,O$ and $Ca:O;H,O$, or as $\frac{K\,|\,O}{H\,!\,O}$ and $\frac{Ca\,|\,O}{H\,!\,O}$? Are these salts of the form $\frac{+}{+}\,\frac{+}{+}$ or $\frac{+}{+\,+}$? or is one of these to be represented in one way and the other in the other? or do either or both of these belong to some intermediate grade, as $\frac{+}{+}\,\frac{+}{+}$?

Uncertain formulæ for certain salts unsatisfactory.

172. It is the uncertainty on this point which permits the view, that the true formula of these compounds is $\left.\begin{matrix}K\\H'\end{matrix}\right\}O$, $\left.\begin{matrix}Ca\\H'\end{matrix}\right\}O$, as is maintained by the "Unitarian" chemists to be held without any contradiction of ascertained principles. I am not about to attempt to decide this point, either by argument or by dogmatic assertion, but I must suggest what seems to me probable. I consider the co-ordinate notion, that the Carbonate of Potassa [Oxycarbete of Potassium, or, briefly, Kali-carbete] is fairly represented by the formula $\left.\begin{matrix}K_2\\CO\end{matrix}\right\}O_2$,* to be untenable, on these grounds:—First, it either ignores the stylobasic construction of the salt altogether; or, secondly, if it accepts that condition it falsifies it by placing the CO in a similar position to that which is given to the K, whereas these two portions of this salt appear in the voltalysis on opposite sides of the compound. Thirdly, it has never been shown that in any compound either is CO connected with O, or C with O_2, by means of the voltaic attachment; therefore in the case of this salt there can be no dispute between these formulæ $\left.\begin{matrix}K'_2\\CO\end{matrix}\right\}O_2$ and $K:O;C,O_2$; the former does not represent the anatomy of the compound, the latter does. The same reasons are valid against putting the formula into the shape $\begin{matrix}K\\CO:O\end{matrix}\Big|\begin{matrix}O\\\\\end{matrix}$ or $\begin{matrix}K\\C\end{matrix}\Big|\begin{matrix}O\\\\O_2\end{matrix}$; the same statement is true, *mu-*

* See Qu. Journ. Chem. Soc., vol. iv. p. 353.

tatis mutandis, of the corresponding Calcium salt. Now water will replace CO_2 [Oxycarbere] in either of these two compounds, and will permit that molecule to be substituted for it in the results so obtained; it is in short interchangeable in these cases with that epistyle, and seems therefore to play the same part with it in them. This would incline us to believe that in these hydrous* salts, the "hydrates" of the strong bases, the water acts as an epistyle, and that their general formula is—

$$B{:}O;H,O.\dagger$$

Various possible positions of water in Hydrates.

On the other hand, the compounds of water with the oxides of other metals which act as Antibases, such as Si,O_3 [Silicire] and SbO_5 [Oxy-Stibure or Antimure], are unquestionably of the form—

$$H{:}O;A,O_n,$$

being hydrostyles. Here the water is at the other extremity of the compound. Now we have metals occupying, though not in rectilinear series, very numerous intermediate grades of qualities between

* By hydrous I mean containing water.

† It is evident that the one molecule of water which adheres so strongly to the Alkaline Oxy-bases, so as to be inseparable from it by heat, lies in the compound in a condition different from that occupied by any other portion of water which may be attached to it. Thus we have no reason for supposing that in the crystalline compound formed by $KO + 5(HO)$, the four supplementary molecules of water are present as part of the style of the salt. They undoubtedly act as the simple constituents of a multiple salt, the constitution of which is perhaps quintuple, thus $\frac{K}{(H}\Big|\frac{O;H,O}{O)_4}$.

together with Oil of Bitter Almonds [Benzaric Acid]. This formula, which would be that of a triple hydrostyle, being the same as that of "Formobenzoic Acid,"* with $H:C_2N$ added to it, is a most unlikely constitution. For it is highly improbable that the stylic character of C_2N should here disappear, leaving its H. no longer replaceable. Again, it has been argued that this compound is "Fumaric" [Fumiric]† Acid, with Benzamide annexed to it: thus, $\underbrace{H:O;C_4H,O_3}_{\text{Fumaric Acid.}}.\underbrace{N,\left\{\begin{matrix}C_{14}H_5O_2\\H_2\end{matrix}\right.}_{\text{Benzamide.}}$. This formula would bring it under a new family of acids, closely allied to our last group, but differing from them in that the ep-epistyle does not contain a molecule derived from the acid, but from another compound. To such a family this body in all probability belongs. However, the fact that when it is boiled with stronger acids it yields Benzoic Acid [Hydrobenzite], affords a strong ground for believing that this latter is the fundamental hydrostyle to which the ep-epistyle is attached, and that thus the molecule $C_{14}H_5$ belongs, not to the secondary adjunct, but to the epistyle. Under this view, transposing the molecules $C_{14}H_5$ and C_4H, we find that the adjunct assumes a form equally analogous to that of our last set of basistyles, in that it contains a molecule derived from an epistyle by loss

Hippuric Acid.

* See § 190, p. 174. † See § 187, p. 166.

Hydrogen is one of the weakest of the bases, being expelled from most of its salts by most of the Basic metals; so that if there are transitions from the district of Bases to that of Antibases, through species which combine the qualities of both kinds, one such passage is likely to be found lying through

loose notions that are prevalent with respect to the Voltaic force and the Stylobasic attachment. If it is represented that a certain class of metals is volta-positive and another volta-negative (than which latter a more prolific error does not prevail), and that the oxides of these are respectively positive and negative to each other, according to the relative condition of their nuclear metals, great confusion is introduced into our scheme. The truth is this: no metals are volta-negative, or but one or two very doubtfully, and these only outlying or hypotypical species; and no oxides of metals are either volta-positive or negative. There is another distinct force, not voltaic, which unites epistyles to prostylobases; the energy of this attachment in prostylobases does, in the species occupying one part of the class of metals, correspond very closely to the voltaic energy of the bases, but not in those belonging to another part of the series; thus Nickel is decidedly basic in certain states, and its Un-oxide [oxade] is conformably prostylobasic. But Silver has a very weak attachment for Oxygen, yet its oxide, once formed, has a strong tendency to combine with epistyles. The quality of the oxide which does strictly depend upon and is proportional to the Basicity of the Base, is its Alkalinity, or solubility in water. The development of this property in an oxybase is proportional to the degree of eagerness with which it exchanges its Oxygen for more energetic styles. In this process the Oxygen is the vehicle by which the base is brought into contact with the new style. (See note to § 107, p. 85.) This is a very different faculty from that of attaching additional molecules (epistyles) to the Oxygen. It is important to bear in mind this distinction between Alkalinity and Prostylobasicity. Every strong Alkali is a strong prostylobase; but the converse is not true. (See Part III. ch. v. sec. 4.)

CHAPTER IV.

OF STYLES OF THE THIRD GROUP.

SECTION I.

Of the Analogies of Styles of the Third Group to those of the Second.

175. We have defined this Group of Styles* as containing those which, "being complex, are neither themselves known separate from a base nor can be divided into such sub-members as that one of them being by itself a style, they by joint reunion with a base will again produce a salt containing the original style." Though none of the salts of this group have hitherto been split into a prostylobase, and an epistyle with a tangible antibase, yet they all seem to be constructed on the same plan as those of the second group. Thus, just as is the case with a very great number of salts of the second group, very many of these others contain on their stylic side just four atoms of Oxygen, of which one seems to be the volta-negative molecule of a primary oxybase, to which the rest of the compound is attached. We are

Styles of the Third Group probably on same type as those of the Second.

* See § 52, p. 40.

almost compelled, by the regularity of the occurrence of this composition, to conclude that in these cases three of the atoms of Oxygen are the metastyles of an epistyle containing a definite Antibase. Some of these compounds seem to contain each a simple Antibase, consisting of one elementary atom; such is the compound $K:O;Cl,O_5$, in which ClO_5, though at present unknown in the free state, is probably the epistyle with the Antibase Cl. Others of them seem each to have a complex Antibase, consisting of a plurality of atoms of the same element; of these $H:O;C_2,O_3$ may be taken as the type; $H:O;S_2,O_5$ probably belongs to the same family; of others the antibases seem to be complex bodies, consisting of Carbon and Hydrogen and sometimes another element; of this form $H:O;C_2H,O_3$ is an instance.

Their epistyles will probably be hereafter isolated.

176. It is difficult to conceive that the styles of these and of numerous other similar compounds are formed on a model essentially different from that on which the Styles of our Second Order are built. We have indeed instances of bodies which, being closely allied to these basistyles, could not logically be separated from them in a general system representing the affinities of all chemical compounds, and which nevertheless come under the definition which, for present convenience, I have taken for our second group of salts. Thus Acetic [Acetiric] Acid, $H:O;C_4H_3,O_3$, as has been stated above, has on its volta-negative side a true epistyle, which may be separated from the prostylo-

sumption and rejection of water which they involve:—

$$\underbrace{H:O;C_{18}H_8NO_5}_{\text{Hippuric Acid.}}+H:Cl+2(H:O)=\underbrace{H:O;C_{18}H_7O_7}_{\text{Benzoglycolic Acid.}}+H_3N;H:Cl$$

$$H:O;C_{18}H_7O_7+2(H:O)=\underbrace{H:O;C_{14}H_5,O_3}_{\text{Benzoic Acid.}}+\underbrace{H:O;C_4H_3,O_5}_{\text{Glycolic Acid.}}$$

$$H:O;C_4H_3,O_5+H_3,N;H:Cl=\underbrace{C_4H_5O_4,N;H:Cl}_{\text{Glycocine-hydrochlorade.}}+2(H:O).$$

But if we suppose that "Hippuric Acid" is "Benzoic acid" with one ep-epipole, and that Benzoglycolic Acid is the same hydristyle with another such adjunct,* thus,—

$$H:O;C_{18}H_8NO_5=H:O;C_{14}H_5O_3.N,\left\{\begin{matrix}C_4HO_2\\H_2\end{matrix}\right.$$
$$H:O;C_{18}H_7O_7=H:O;C_{14}H_5,O_3.C_4H_2O_4,$$

the two kinds of change to which Hippuric Acid is liable, as well as the decomposition of "Benzoglycolic" Acid, will appear very simple. Thus:—

$$H:O;C_{14}H_5,O_3.N\left\{\begin{matrix}C_4HO_2\\H_2\end{matrix}\right.+H:Cl+2(H:O)$$
$$=H:O;C_{14}H_5,O_3+\left.\begin{matrix}C_4H_3O_4\\H_2\end{matrix}\right\},N;H:Cl.$$

Here the adjunct alone is affected, to wit, by the

* This adjunct, it may be observed, has the composition of "Fumaric Acid," $H:O;C_4H,O_3$, but it is not likely that it has any connection with that substance: its probable constitution will be indicated immediately (see § 201, p. 188). If this molecule were "Fumaric Acid," "Benzoglycolic Acid" would be a double hydrostyle analogous to glycolic acid (see § 190, p. 175), but having only one molecule of Hydrogen easily replaced; thus, $\begin{matrix}H\\H\end{matrix}\Big\}O;C_{14}H_5,O_3$.
$H\}O;C_4H,O_3$

known in the free state. On this ground then with respect to the Salts of this Third Group, I would call all that part of them which is ove and above the primary water, or other halobas which is involved in them, by the term Epistyle and I would call that part of such epistyle whicl seems to be the nucleus, to the combination o which, with a certain quantity of the characteris tic halogen, the formation of the epistyle is due by the general term Antibase; and I would cal each molecule of Halogen in the epistyle, which i not part of the Antibase, a Metastyle. Generally unless it is proved, or is highly probable, that part of the halogen belongs to the Antibase, I should assume that all the molecules of halogen in the epistyle are metastylic.

Such application of terms to be limited by sound analogy.

178. It must be remembered that to include under general forms of expression already applied to certain known substances, other molecules which correspond to them in position and in composition but of which it is not actually known, though al analogy would lead us to believe that they have existence, is a sound method in nomenclature; bu to give names to groups of molecules which do no correspond to any fixed type, and of which analogy does not warrant us in anticipating the existence is a very different proceeding.

A *special* nomenclature is also requisite.

179. Next to the general terms applied to th comparative anatomy of our compounds, the spe cial nomenclature of their different kinds claim consideration.

consideration of the class of compounds represented by H_3N, and of the modifications of which they admit.* But there is another view which we may take of the constitution of Benzoglycolic Acid. This view is suggested by the composition of the molecule which it contains in excess of the elements of Benzoic [Benziric] Acid, and by the probable homology of this Benzoglycolic Acid with "Benzolactic" Acid, which latter contains C_3H_2 more than the former Hydristyle. These two acids are probably similarly constituted, and whatever relation the one bears to Glycolic Acid, the other as probably bears to Lactic Acid. Now the molecule by which "Benzoglycolic" Acid exceeds Benzoic Acid is $C_4H_2O_4$. Similarly Benzolactic Acid ($H:O;C_{20}H_9O_7$) contains $C_6H_4O_4$ more than the same acid. But $C_6H_4O_4$ is the composition of a known substance which is probably the true epistyle of "Lactic" Acid, as has been shown in a former page,† being constituted $\frac{C_2H,O_3}{C_4H_3,O}$. Just so $C_4H_2O_4$ has the composition of the similar double epistyle of "Glycolic" Acid, which is probably $\frac{C_2H,O_3}{C_2H,O}$. Thus we find that each of these two acids has, in its stylic molecule, the elements of three different epistyles; so that they may have such a constitution as is represented by the following formulæ:—

$$H:O;\begin{cases}C_{14}H_5,O_3\\C_2H,O_3\\C_4H_3,O\end{cases}, \text{ and } H:O;\begin{cases}C_{14}H_5O_3\\C_2H,O_3\\C_2H,O\end{cases}. \text{ That is}$$

tic" Acids: compounds with triplex styles.

* See P. III. Ch. V. sec. 6.

† See § 191, p. 175.

$H:O;Mn_2O_7$, the so-called "Permanganic Acid," the epistyle Mn_2O_7 is unknown in the separate state. This molecule I would call Dimanganoire, and its hydrous compound Dimanganoiric Acid, or Hydridimanganoite.

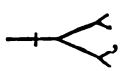
Nomenclature of Oxalic Acid group.

183. Again with respect to Oxalic Acid, $H:O;C_2,O_3$, though we are unable to separate the compound into its members in the free state, we are informed, by the effects of other bases on it, that Hydrogen is basic herein, and we infer that $H:O$ is prostylobasic, as in $H:O;SO_3$; and it is difficult to escape from the belief that the part C_2O_3 corresponds to SO_3, being the epistyle, and that the complex or duplex molecule C_2 corresponds to S in the other body, and is the nucleus or antibase, and that O_3 is extra-nuclear or metastylic; hence we shall be justified by analogy in calling this molecule C_2 Oxalyle, or, better to avoid the ambiguity which the initial syllable "Ox" might occasion, Xalyle, in calling C_2O_3 Xalire, the salts $B:O;C_2O_3$ Xalites, and $H:O;C_2,O_3$ Xaliric Acid, or Hydro-xalite.

Of Formic Acid group.

184. The close analogy of Acetic [Acetiric] Acid to its co-serial "Formic Acid" $H:O;C_2H,O_3$, compels us to suppose that the molecule C_2H plays in the former the same part which C_4H_3, the antibase Acetyle, does in the latter. We may therefore say that C_2H is here the antibase. We may call this molecule, as is already the custom, "formyle"; and the epistyle C_2H,O_3 we may call "formire," giving to the acid itself the name "formiric," or hydroformite.

plex styles, the only isolable epistyles which can be obtained from them are the original single molecules $C_4H_2O_5$, C_7O_3, Bo,O_3, Sb,O_3, As,O_3, $C_{14}H_5,O_3$; but in the case of "Benzolactic Acid" two of the epistylic molecules seem to cohere permanently, when the system is broken up, as the double epistyle of "Lactic Acid." triplex-styled salts.

206. There are probably also among the zoogenic single hydrostyles many other instances in which two molecules of epistylic nature, or at least of epistylic form, have cohered to form a single epistyle. In these cases it will sometimes be doubtful whether the secondary epistylic molecules occupy the same position in the salts as do the primary ones, or whether their dignity is different; that is to say, whether the formulæ of such salts are of the form  , or should be written $B:O;Ab,O_n.x$, where x represents an exepistyle. This point is in each instance to be determined by appropriate inquiry and reasoning, in which the physiology, or chemical behaviour of the compound, will be the surest guide to its true anatomy. Doubtful position of secondary epistyles.

Section III.

Of certain Multiple Salts having Styles of the Third Group, but containing only one Molecule of Epistyle.

207. There are also among the unisolated single epistyles of this group some which require a plu- Salts of polybasic hydrostyles: "Tartaric Acid."

Probability of a series parallel to the Elæogenous.

187. Suberic [Subiric] Acid, $H:O;C_8H_6$, probably a co-serial homologue of Succinic There is probably another series of hydr parallel to the Elæogenous line, and containin atoms more of Carbon in the antibase than do of the other series. Thus we have $H:O;$ "Mellitic Acid," which in its composition to the members of this new series the same tion as that which Oxalic Acid, $H:O;C_2O_3$, to the others. The first of the Hydrogenous bers of this set will be either "Fumaric" $H:O;C_4,H,O_3$, which we may call Fumir having an antibase "fumyl," C_4H, and e "fumire," C_4H,O_3, or "Aconitic" or " ic" Acid, both of which are isomeric with compound. Acrylic [Acriric] Acid is p the second ($H:O;C_6H_3,O_3$); "Camforic" $H:O;C_{10}H_7,O_3$, possibly is the fourth co- with one or other of these; "Pyrotartaric" $H:O;C_6H_3,O_5$, may be a pentadactylic co-s of the second of this line.

Nature of radical of the Benzoic Series discussed.

188. Oil of Bitter Almonds is a very int ing member of the stirps to which Benzoic [Benziric hydrostyle] belongs. It is generall sidered to be the Hydruret of (compound o drogen with) "Benzoyle," $C_{14}H_5O_2$, the su radical of this stirps. We have however no reason for believing that any such Benzo the root-molecule of the compounds "Ch of Benzoyle," $C_{14}H_5O_2Cl$ [Unichlo-benzime anhydrous Benzoic Acid, $C_{14}H_5O_3$ [Benzire]

we have for stating that "Carbonic Oxide," C,O [Carbame], and Sulphurous Acid, S,O_2 [Sulfere], are the root-molecules of Chloro-carbonic Acid, C,OCl [Unichlo-carbeme], and "Carbonic Acid," C,O_2 [Carbere], and of "Chlorosulfuric Acid," S,O_2Cl [Unichlo-sulfime], and "anhydrous Sulfuric Acid," S,O_3 [Sulfire] respectively. There is true parallelism between the three series of compounds. In the two latter cases we can descend by analysis to C and to S, as the root-molecules of these bodies, and from these elements we can ascend synthetically to the higher compounds. Analogy invites us to infer that $C_{14}H_5$ [Benzoyle] is the root-molecule of the Benzoic series. There is indeed less reason for assuming $C_{14}H_5O_2$ as a radical than for applying this term to C,O and S,O_2, because we cannot isolate it as we can these latter compounds. The same considerations apply to certain other so-called "organic radicals;" for example, to "Salicyle" ($C_{14}H_5O_4$), "Cumyle" ($C_{9}H_{11}O_2$), and "Cinnamyle" ($C_{18}H_8O_2$). It is however evident, from the behaviour of the compounds $C_{14}H_5,O_2Cl$ and $C_{14}H_6O_2$, that the molecule of Chlorine in the former does not represent in position the sixth atom of Hydrogen in the latter, that is to say, that if in any sense the former is the Chloride of "Benzoyle," the latter is not in the same sense a "hydruret" of the same "radical." The molecular system must have changed its form under the substitution of the Cl for H that ensues in the action of Cl upon $C_{14}H_6O_2$. The former

compound generates Benzoate [Benzite] of Potassium by simple interchange with hydrated potassa. But to the formation of the same compound from the latter, a process of direct oxidation is necessary, which may be effected either by the action of the air or by the decomposition of water, with liberation of Hydrogen. Thus, representing $C_{14}H_5$ by Bz,

$$2(K:O;H,O) + Bz,O_2Cl = K:O;Bz,O_3 + K:Cl + 2(H:O),$$

and,

$$K:O;H,O + H:O;Bz,O = K:O;Bz,O_3 + 2H.$$

Again, the "chloride" under treatment of H_3N generates Benzamide $= \left.\begin{matrix} C_{14}H_5O_2 \\ H_2 \end{matrix}\right\}N$, while the so-called "hydruret," with the same agent, gives rise to "hydrobenzamide," $\left.\begin{matrix} (C_{14}H_5)_3,N \\ H_3,N \end{matrix}\right\}$. The two bodies are evidently constituted on a different type. Again, if we have no especial grounds for believing in $C_{14}H_5O_2$ and its above-mentioned analogues as existent "radicals," we have no reason to conclude that compounds containing one atom more of Hydrogen than is involved in these groups are compounds of Hydrogen, with the said "radicals," or that they contain these radicals at all. Thus then if we are not compelled to believe in $C_{14}H_5O$ as a "radical," we need not be convinced that Oil of Bitter Almonds ($C_{14}H_6O_2$) ought to be written $C_{14}H_5O_2$—H, as having one of its atoms of Hydrogen united by an altogether peculiar force to the rest of the compound. But we may fairly entertain the notion that this one molecule of Hydrogen

hich certainly has a position different from that f the other atoms of this element in the oil, is onnected with the rest of the compound by some ich tie as we know to unite it with other com-lex groups; thus this compound may consist of ater coupled in some form with another oxide. hus $C_{14}H_6O_2$ may be either $H:O;C_{14}H_5,O$ or $\frac{H\,|\,O}{C_{14}H_5\cdot O}$; that is to say, it may have the consti-ution of an aldehyde or of an alcohol; it may ear just the same relation to Benzoic [Benziric] .cid that Aldehyde, $H:O;C_4H_3,O$ [Acetaric .cid] does to Acetic Acid, $H:O;C_4H_3,O_3$ [Ace-ric Acid]. In such case we should call it Ben-aric Hydristyle, or Hydrobenzate, as having the pistyle $C_{14}H_5O$ [Benzare]. This is a more likely ormula than the second which I have suggested, s we have no indication that the molecule $C_{14}H_5$ basic, while we have many reasons for thinking iat it is not. It is probably rendered Antibasic y the annexation of C_2 to the basic molecule $_{12}H_5$, just as C_2H_3 (Methyle) ceases to be basic, id becomes Antibasic by annexation to C_2, in $_4H_3$ (Acetyle).* The same consideration bears pon the supposed hydurets of the non-basic so-

* So, as Chancel has shown (Compt. Rend. t. 28, p. 83), Benzone," or, as he calls it, "Benzofenone," is probably $_2H_5:O:C_{11}H_5,O$ [Benzate of Fenyle], being, according to is view, Oil of Bitter Almonds, in which $C_{12}H_5$ is substituted r basic H, and in which the same molecule, with the addition C_2, occurs in the Antibase.

called "radicals,"* most of which compounds belong to the "aromagenous" family.

"Salicylous" and "Salicylic" Acids, etc.

189. Thus "Salicylous Acid," which is sometimes called "Hyduret of Salicyle," and which has the same composition with Benzoic Acid, bears to Salicylic Acid [Hydrosalisute?] (of which, as we have seen, the epistyle is known)† the same relation which Aldehyde and Bitter Almond Oil bear to Acetic and Benzoic Acids respectively. It contains probably the same antibase as that of its co-stirpial, namely Salisyle,‡ $C_{14}H_5$, isomeric with Benzyle, and an epistyle, Salisire, $C_{14}H_5,O_3$, isomeric with Benzire; the difference of the two systems being supposed to arise from differences in the molecular construction of the two groups of $C_{14}H_5$.§

* The theory of these "Hydurets" and their "radicals" is a most improbable one. It implies that these "radicals"—"Benzoyle," $C_{14}H_5O_2$, "Salicyle," $C_{14}H_5O_4$, etc.—are a set of complex styles *sui generis*, not belonging to either of our three groups. These "radicals" claim to be, like Cyanogen, autostylic, and not resoluble into halogen and epistyle, yet, unlike this body, but like the styles of our third order, they are not separable, without decomposition, from their basic H. or other similar molecule.

† See § 130, p. 108.

‡ The Salisyle here so called is not the group of atoms to which the name Salicyle is given by the standard authorities.

§ If it should be proved that the nuclear group, or Antibase, of this "Salicylous Acid" is $C_{14}H_5O_2$, that is, that two of the atoms of oxygen belong to the Antibase, and that only one is metastylic,—and for this notion sound reasons may be urged,—then, the name Salisyle being given to this oxygenous antibase, the hydrostyle, commonly called Salicylous, will be called Salisaric, or Hydro-salisate; and the Salicylic Acid of the current nomenclature will be Salisiric hydrostyle, or Hydrosalicite; their

constitution and appropriate name, then, of compound, and its relation with its co-stirpial, s follow:—

icylous acid=H:O;$C_{14}H_5,O_3$=Hydrosalisite.
icylic acid =H:O;$C_{14}H_5,O_5$=Hydrosalisute.

propriety of the application of the same theory e oxygenous Cumin Oil, H:O;$C_{20}H_{11},O$ [Cu- hydristyle] is clearly indicated by the for- on of the compound K:O;$C_{20}H_{11},O$, by treat- his oil with Potassium. This body, like Bitter nd Oil and Aldehyde, passes by simple oxida- into the corresponding tridactylous Hydristyle ;$C_{20}H_{11},O_3$, Cuminic [Cumiric] Acid. So

es, $C_{14}H_5O_2,O$ and $C_{14}H_5O_2,O_3$ being, in that case, Sali- nd Salisure respectively. This view of the difference be- "Benzoic" and "Salicylous" Acids is distinct from that is taken in the text. Their differences will depend, if such truth, on the difference of their Antibases, as respects not constitution, but composition, and on the fact that one has single molecule of metastylic oxygen, while the other has The same doubt occurs as to the composition of "Anisic" namely whether it be H:O;$C_{16}H_7,O_5$ or H:O;$C_{16}H_7O_2$, In the former case (that is, if its antibase be $C_{16}H_7$) this e either the same as the antibase [Tolyle] of Toluylic Acid, H:O;$C_{16}H_7,O_3$, or it may be isomeric therewith; isomeric with Tolyle, the name of this antibase would be yle." If however $C_{16}H_7O_2$ be the antibase, we shall have ly the term "Anisyle" to this oxygenous molecule. So drostyle itself may have to be called either Toluric [Hydro- , Anisuric [Hydr-anisate], or Anisiric [Hydr-anisite]. art III. Ch. V. 2.) It is worthy of remark that as there seem two series of basic molecules of the form $C_{12}H_5$,—$C_{14}H_7$, the members of which are isomeric with each other (see II. Ch. II. 3. and Ch. V. 2.), so there may also be two co- eries of isomeric antibases of the form $C_{14}H_5$,—$C_{16}H_7$, etc.

"Hyduret of Cinnamyle" is probably $H:O;C_{18}H_7O$ [Cinnamaric Acid], which by oxidation becomes $H:O;C_{18}H_7,O_3$, Cinnamic [Cinnamiric] Acid. "Cyanic," "Sulfocyanic," and "Persulfocyanic" Acids are hydrostyles of this form, being probably constituted thus, $H:O;Cy,O$,—$H:S;Cy,S$, and $H:S;Cy,S_2$, Cyanogen being here, in each case, the antibase. The epistyles, being monodactylic, would be called, in accordance with our system, "Cyare," "Sulfocyare," and "Sulfocyere," and the acids "Cyaric," "Sulfocyaric," and "Sulfocyeric" respectively. Neither of these epistyles are known in the free state: nor have any of the styles been isolated, though a substance doubtfully represented as having the composition Cy,S_2 is sometimes spoken of as the "radical Sulfocyanogen," *i. e.* as the style of the bisulfurous Acid. If such be its composition, it is more likely to be the epistyle of the other bisulfurous compound. The first of these three acids is obviously analogous to the Hydrostyle $H:O;Cl,O$ [Hydrichlorate], which contains the known epistyle Cl,O [Chlorare].

Section II.

Of Styles of the Third Group which seem to contain more than one Epistyle.

Styles with "ep-epistyles," or adjuncts to epistyles, *e.g.* Formobenzoic Acid.

190. In our Second Group of Styles we have found some which contain two epistyles:* there are also some salts, whose styles we must at pre-

* See § 100, p. 77.

obtain a totally new and much more satisfactory notion of the constitution of the system. If then for every two symbols of basic Fe we substitute in our formula three units of Fe′, it becomes—

$$\left.\begin{matrix}\mathrm{Fe'}\,|\,\mathrm{Cy}\\ \overline{\mathrm{Fe'}\,|\,\mathrm{Cy}}\end{matrix}\right\};\mathrm{Fe,Cy}$$

$$\left.\begin{matrix}\mathrm{Fe'}\,|\,\mathrm{Cy}\\ \overline{\mathrm{Fe'}\,|\,\mathrm{Cy}}\end{matrix}\right\};\mathrm{Fe,Cy}$$

$$\left.\begin{matrix}\mathrm{Fe'}\,|\,\mathrm{Cy}\\ \overline{\mathrm{Fe'}\,|\,\mathrm{Cy}}\end{matrix}\right\};\mathrm{Fe,Cy.}$$

This, which is the formula of a sextuple salt, represents a triple repetition of one and the same molecule. We have no reason to suppose that the compound has any such complexity; we are therefore quite at liberty to divide it by three. By this simplification it becomes plain, $\left.\begin{matrix}\mathrm{Fe'}\,|\,\mathrm{Cy}\\ \overline{\mathrm{Fe'}\,|\,\mathrm{Cy}}\end{matrix}\right\};\mathrm{Fe,Cy}$, in precise accordance with the archetype Ferrocyanide [Cyaferrate]. Here, then, by this simple plan we represent the constitution of the body by six symbols instead of sixteen: the mystery of its structure vanishes, and its formation by direct precipitation is shown to be an ordinary case of the double interchange of bases, thus:—

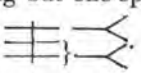
$$2(\mathrm{Fe'{:}Cl}) + (\mathrm{K{:}Cy})_2;\mathrm{Fe,Cy} = 2(\mathrm{K{:}Cl}) + \underbrace{(\mathrm{Fe'{:}Cy})_2;\mathrm{Fe,Cy}}_{\text{Prussian Blue.}},$$

The generation of this substance by halization from the white precipitate formed by the action of "Ferrocyanide" of Potassium on a Ferristyle, is precisely analogous to the production of the "Sesquichloride of Iron" [Ferrici-chlorade] from the

"Proto-chloride" [Ferri-chlorade], thus:—

$2(Fe:Cl)+O=2(Fe':Cl)+Fe':O$, and

$(Fe:Cy)_2;Fe,Cy+O=(Fe':Cy)_2;Fe,Cy+Fe':O.$

Such a substitution of normal simplicity for abnormal complexity lends certainly some support to the theory on which it is unded, that of the twofold molecular value of metal Iron. It is probable that, besides the co unds of the form which we have here insta any of the organic Acids [Zoogenic hydr are Multiple Salts. Some of these, though ing more than one epistyle may have a less number of such molecules than o prostylobases. Some, for example, may be compounded of a monohale with a diplohale, each having but one epistyle; such Salts would be of the form  . Of others again, owing to the different energies of the several stylic molecules, all the basic members may not be equally easily replaceable: instances of this kind have been already mentioned.* It is clear that the varieties of construction of which these systems admit are very numerous.

Section IV.

Of a Better Classification of Styles.

The composition of a body is absolute; its constitution is uncertain.

216. We have now completed our survey of the volta-negative side of Single Salts, and have made such collateral observations on the stylic members

* See § 192, p. 176.

omplex molecule. The simplest case of this kind s the addition, to the primary acid, of a compound lready existing, and not depending for its formaion upon a molecule similar to that to which it dheres. Formobenzoic Acid is usually taken to e an instance of this kind of complication, being produced by the combination of Formic [Formiric] Acid, $H:O;C_2H,O_3$, with Oil of Bitter Almonds ($C_{14}H_6O_2$). The salts produced by the replacement of the basic H. of this compound might thus be written, $B:O;C_2H,O_3.C_{14}H_6O_2$.

Composition of Lactic and Glycolic Acid.

191. With Formobenzoic Acid we may probably class Lactic Acid, $H:O;C_6H_5O_5$, and its homologue Glycolic Acid, $H:O;C_4H_3O_5$, both of which have been, with some probability, supposed to be Formic Acids, each with a different ep-epistyle. These adjuncts are taken to be, respectively, the "Aldehydes" of the Acetic and Formic Acids. According to this view, Lactic Acid would be

$$H:O;C_2H,O_3.C_4H_4O_2,$$

and Glycolic,

$$H:O;C_2H,O_3.C_2H_2O_2.$$

But now if we remember that the "Aldehydes" contain the antibasic molecule of the tridactylous hydrostyles of the several series, and that, as illustrated by the formation of "Aldehyde Ammonia," $H_3,N;H:O;C_4H_3,O$, they are probably themselves hydrostyles,—that is, that they are bipolar compounds, with basic Hydrogen and a complex style, —we shall be inclined to give a different shape to these formulæ. Thus we shall write—

In Third Group Antibases of Zoogenic origin.

…gen and a few other elements occasionally … place in it.

7. The distinguishing attribute is, that their … nbases are complex bodies built up by the forces of zoogenic chemistry. We could not have arrived at this without fir… …g to a clear notion of the function of an An…

Definitions of three Groups of Styles.

218. We t… definitions of the three Groups or … …es, as, with the precision which we have … …ed, we may call these divisions, thus m…

GROUP 1.—Styles … are known, separate from any Base, as free substances.

GROUP 2.—Styles that contain Antibases, which consist of either Geogens, Halogens, or elementary Zoogens.

GROUP 3.—Styles that contain complex Antibases, which consist of either Zoogens solely, or of Zoogens united either with Geogens or with Halogens, or with elements of both these classes.

First Group, the Order of Autostyles.

Second and Third Groups, the Order of prostylepistyles.

Third Order, that of expistylous styles.

219. To the members of the first of these groups we may give the distinctive term Autostyles.* It forms a distinct Order, and includes at present two families. Of these, one contains all those styles which are elementary bodies belonging to the class named, by way of excellence, "The Halogens;" the other family consists of the Compound Styles of the type represented by Cyanogen; of these only two species are known. These styles have no antibases in their composition. By the introductio…

* See § 57, p. 44.

s term "Antibase" into the definition of these
s, Cyanogen and its similars are excluded
the Third Group. The Second Group, as thus
tuted, will include such styles as those of
Cl,O_5 [Chloruric Acid], $H:O;S_2O_2$ [Disul-
Acid], and of any other hydrostyles which
alogens for their antibases, but of which the
les are as yet unknown in the free state.
bodies are thus brought into juxtaposition
hose salts to which they are most nearly al-
ut which differ from them in having known
ntive epistyles. On the other hand, our Third
will now receive the styles of such salts as
Ac,O_3 [Acetiric Acid], $H:O;Kd,O_3$ [Kako-
cid], $H:O;Trt,O_5$ [Tarturic Acid], and of
her zoogenous hydrostyles whose epistyles
rove to be isolable. The Second and Third
above Groups, namely, those of the Epi-
Styles, constitute together a Natural Order.
the members of which each member of this
is made up, we may describe it as that of
styl-epistyles. The subdivisions of its two
will depend on the various characters of
tibases involved. Besides these autostyles
les, consisting of prostyles and epistyles, we
third Order of stylic systems of a yet higher
of complexity. These are the styles which
ex-epistyles or additional molecules ap-
to their epistyles. There are a considerable
of these, but the laws of their construc-
d the relations of the different species to
her are at present somewhat obscure.

Salts conveniently classed,—generically by their bases, specifically by their styles.

220. It must be remembered, while thus speaking of the classification of Styles, that we are not discussing under this name natural species, which can be handled and arranged like the Salts which they help to constitute. Since the styles of the second and third orders are not isolable, it might seem more true to nature to classify, not the styles themselves, but the actual Salts according to the styles which characterize them. But in forming a catalogue or museum of Salts we should have no greater reason for setting them in order according to the affinities of their styles than according to the relations of their bases. Obviously we may follow either plan in sketching out our scheme; it would however, as it happens, be more convenient to arrange Salts primarily according to their bases; for this reason, that in nature we have a far greater number of basic species (visible substances) than of stylic forms of matter. This law prevails not only among the elements,—of which, at most, only nine are stylic, while more than forty have basic properties,—but also among compounds. We know only two, perhaps with certainty only one compound style; but several compound bases are reported, as we shall presently see. Having taken then the bases as the standards under which the Salts are to be grouped in the larger divisions, we may very properly subdivide these groups according to the styles of the various species. It is to this purpose of secondary arrangement that the hypothetical classification of the styles is adapted.



PART III.

OF BASES.



CHAPTER I.

OF BASES IN GENERAL.

SECTION I.

Of the Simple Bases.

Bases are complex as well as simple.

221. I have already,* in opening the discussion of the constitution and nomenclature of Salts, complained of the perplexing want of precision which prevails in the usage of the term Base; and, taking the Ammonia compounds as instances, I mentioned that this term Base was applied indiscriminately to bodies corresponding in function to H_3N [Ammonine], to $H_3,N;H$, "Ammonium," and to $H_3,N;H:O$ [Ammonia]. The confusion with respect to the word Acid is more tolerable than that which attends the term Base: we had only two kinds of bodies confounded under the former name; three are thus jumbled together under the latter. According to the form of definition which I have selected, the term Base must be applied only to bodies which may occupy such position in a salt as is held by K. in the salt K:Cl, and by $H_3,N;H$ in the salt $H_3,N;H:Cl$. By thus illustrating the

* See § 26, p. 18.

question, I have made the statement which, however familiar, is required at this stage of the inquiry, that, just as we have simple and complex styles, so we have co-ordinately Bases complex as well as simple. The so-called "Ammonium," $H_8, N; H$, is an instance of a complex base. The most important subject which remains for us to consider is in connection with the constitution of Salts,—that of the rational or models on which the complex bases are constructed.

Two types of simple bases. 1. Metallic bases.

222. We shall be led to the recognition of the archetypal forms, if such there be, of the complex bases, by considering first what the simple bases are; and we may then discuss the relations which they may have with such of their complex analogues as most prominently present themselves to notice. Of such undecomposable bodies as, under our definition, we have to consider as bases, we find two very distinct types: the one of these is metallic, and includes a number of metals, of which some differ very much from others in their more special properties, but of which all are united by this tie of similarity, that they combine with the Halogens in pairs of single equivalents of each (base and halogen) to form salts, which are for the most part solid, and which may be decomposed by the voltaic current, the base being rendered always at the negative voltode. The basic quality is often taken to be characteristic of the metals, insomuch that "Hydrogen" is sometimes said to be a gaseous metal, and "Ammonium" to be a compound metal.

This is an error; for there are several metals which have not the least trace of basic power, and these are the eminently telotypical species of a primary division of the metallic class.* Basicity is however the leading feature of another division of this class; namely of an Order of equal dignity with that of the antibases to which I have alluded, an Order to the members of which I would give the distinctive appellation Bases. The basic quality also appears in inferior degree in those species of the other Metallic orders which have the nearest affinity with the bases proper. Among the Geogens that act as Bases we may mention K., Na., Li., Ca., Ba., Sr., Mg., Ce., Al., Zr., Be., Zn., Fe., Cr., Mn., Ur., Ni., Co., Cu., Cd., Sn., Bi., Pt., Pd., Hg., Ag., Pb. Some of these enjoy antibasic properties in addition to their basic powers. Several of these metals form two, or even perhaps, in a few rare cases, three distinct series of salts, in which the ratios of the weights of the metals to those of their styles is different. In some of these secondary salts the metal is present in only two-thirds or one-half of the quantity in which it exists in the primary salts. I have already alluded to this point:† I shall have occasion to discuss it more particularly in reference to several of the more interesting metals.‡ I consider that the simplest explanation that can be offered of these facts is, that the metals which have this property are endowed with two, or rarely three, different

* See § 125, p. 103. † See § 211, p. 194.

‡ See note to P. III. Ch. V. sect. 3, and notes to sect. 7. div. i. § 1.

all, though confusedly and inarticulately, collected together under certain heads, within which we could examine, and from which we could redistribute them. But our inquiry concerning the bases, towards the setting them in order and distinguishing their parts by names, must be in the way of synthesis; because, until very lately, almost nothing has been known about them, and what is yet known is in a very scattered condition and nearly devoid of arrangement. Indeed it is certain that we have not yet sufficient materials for a proper classification of the Bases, nor enough knowledge of the constitution of many of them to enable us to represent, by formulæ, the true relations of all of them to each other. Nevertheless very large additions have been made of late years to our knowlege of this branch of chemistry; and these contributions have not all been made in one direction, but cover various points of the natural history of these members of Salts; so that we may reasonably hope, with this help, to attain some distinct and true conceptions as to their general relations. The notions which we have derived from our examination of the stylic side of salts will avail us well in our consideration of the Bases.

in comparatively few such systems. And
als which do enter into the complex bases
very instance yet known, either among the
of the simple bases, or have not, when
ny power at all to fill by themselves the
side of salts. Further, among the complex
nich are specially marked by the Hydrogen
ney contain, we find some of the strongest
of this kind with which we are acquainted.
nplex base $H_3N.H$, for instance, which is
Ammonium," rivals Potassium in its en-
attachment for the halogens; and some
f those which are constructed on a model
o that of $H_3N;H$. seem even to exceed it
power.

First inquiry, what part Hydrogen plays in complex bases.

We may then, in examining the bodies with
e have now to deal, fairly take Hydrogen
tarting-point, and consider their relations
element; and we may naturally commence
uiry into the constitution of the Complex
ith the question—What is the method of
on with other molecules by which the basic
f Hydrogen becomes thus exalted? What
rm of the complex groups so constructed
ydrogen? We may then inquire what part
odies play in the building up of complex

Complex styles better understood than complex bases.

Our discussion of the structure of the com-
es naturally took the analytical form, be-
is part of the subject has been so much
oroughly examined, and the results were

fusedly and inarticulately
certain heads, within
nd from which we
our inquiry concerning
g them in order and
y names, must be
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ent materials fo
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a considerable number of
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which must proba
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term to include this
fore call them "Thyles,
combine with the ha
cyclic molecules, it will be in
thod of nomenclature which
ly convenient in practice,
to express all such saline
then call all such compo
the similar combinations of
Thyles, and salts generally,
ll be the more useful as the
characters of their own, by
market from most other
have very frequent
compounds. On the
(Oxalic), the Ethereid
Oxythylon.
The Thyles

Definition of Thyles and Thylistyles.

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pounds. I
Thylistyles,
drogen are
yles. This
istyles have
ch they dif-
nd because
to speak of
nciples their
ses, may be

bases of the
These bases
Thylistyles
compounds
y probability
mpleted. Of
been isolated,
, but doubt-

Probability of similarity of constitution in Thylistyles.

231. Of the series of Thylistyles the followi oxybases are known :—

Methyl Oxide $C_2H_3:O=Me:O$
Ethyl Oxide $C_4H_5:O=Æ:O$
Amyl Oxide $C_{10}H_{11}:O=Am:O$
Cetyl Oxide $C_{32}H_{33}:O=Ct:O$

and besides the alcohols, hydrates, or double sal of the above, with water, of which presently w shall have to take special consideration, we ha the following :—

Trityl Alcohol . . $\frac{C_6H_7}{H}\Big|\frac{O}{O} = \frac{Tri}{H}\Big|\frac{O}{O}$

Tetryl Alcohol . . $\frac{C_8H_9}{H}\Big|\frac{O}{O} = \frac{Tet}{H}\Big|\frac{O}{O}$

Heptyl Alcohol . . $\frac{C_{14}H_{15}}{H}\Big|\frac{O}{O} = \frac{Hpt}{H}\Big|\frac{O}{O}$

Ceryl Alcohol . . $\frac{C_{54}H_{55}}{H}\Big|\frac{O}{O} = \frac{Cer}{H}\Big|\frac{O}{O}$

Melissyl Alcohol . $\frac{C_{60}H_{61}}{H}\Big|\frac{O}{O} = \frac{Ml}{H}\Big|\frac{O}{O}$

The compounds of the first three of the bases he mentioned (Me., Æ., Am.), with a vast number stylic molecules are known; of the three latter few such have been described. The analogy of t different members of the series among each oth is such as to warrant us in believing that the sa kind of basic quality which characterizes Me a Æ, also belongs, though perhaps with a differen in degree of energy, to their more complex c serials. It is probable also that the constituti

ll these basic molecules, as respects their in-
al structure, is similar. Further, each of the
ple oxides of seven of these bases is closely con-
ted with a hydristyle, containing just one atom
Hydrogen, two of Carbon, and three of Oxygen
re than itself; thus we have—

ic ac^{d} $=H:O;C_4H_3,O_3=Me:O+H+C_2+O_3$[Hydracetite]
ionic $=H:O;C_6H_5,O_3=Æ:O+H+C_2+O_3$[Hydropropite]
rric $=H:O;C_8H_7,O_3=Tri:O+H+C_2+O_3$[Hydrobutite]
rianic $=H:O;C_{10}H_9,O_3=Bu:O+H+C_2+O_3$[Hydrovalite]
oic $=H:O;C_{12}H_{11},O_3=Am:O+H+C_2+O_3$[Hydrohircite]
ylic $=H:O;C_{16}H_{15},O_3=Hpt:O+H+C_2+O_3$[Hydrocaprite]
garic $=H:O;C_{36}H_{33},O_3=Ct:O+H+C_2+O_3$[Hydromargite]

32. Again, we have hydristyles closely related to each of these eight oxythyles, and differing from them respectively in containing one atom of Hydrogen less, and three atoms of Oxygen more than the oxybase, namely,— Definition Antithyles; their nature.

mic ac $H:O;C_2H,O_3=Me:O-H+O_3$[Hydroformite]
ic $=H:O;C_4H_3,O_3=Æ:O-H+O_3$[Hydracetite]
ionic $=H:O;C_6H_5,O_3=Tri:O-H+O_3$[Hydropropite]
rric $=H:O;C_8H_7,O_3=Tet:O-H+O_3$[Hydrobutite]
rianic $=H:O;C_{10}H_9,O_3=Am:O-H+O_3$[Hydrovalite]
lic $=H:O;C_{32}H_{31},O_3=Cet:O-H+O_3$[Hydrospermacite]
tic $=H:O;C_{54}H_{53},O_3=Cer:O-H+O_3$[Hydrocerotite]
ssic $=H:O;C_{90}H_{89},O_3=Ml:O-H+O_3$[Hydroapite].

the hydrostyles here mentioned belong to the
ie series, one in which each member contains
H_2 more than the member next below it in the
e. This common difference or increment of
H_2 belongs to the antibase in each of these
rostyles. Each member of the series of anti-
es that are involved in these bodies, differs by

large number of the compounds of ethyl with the simple halogens and with several complex styles have been constructed, and these compounds may be formed very regularly by double decomposition, under appropriate circumstances, from the compounds of the same negative molecules with hydrogen and with certain metallic bases; so that there can be no doubt that the Thyles hold in these compounds, as respects the styles, the same position that Hydrogen, Potassium, or any basic metal occupies in the hydrostyles or in the metallic salts. Thus their oxides [oxades] are clearly analogous to water. We can have no clearer or more useful conception of their nature than that which we obtain by considering them as waters, which differ from ordinary water in having, instead of hydrogen, molecules containing Hydrogen and Carbon on their positive side. We shall then readily understand that the divergence in behaviour which they present when compared with protypical water may be due and correlative to this modification of their basic molecules.* Like H:O, these oxythyles will

Methyle and Butyle at the anode in the voltalysis of Acetic Acid [Acetiric hydristyle] and Valerianic Acid [Valiric hydristyle]; and Brazier and Gossleth obtained Amyle and Caprotyle ($C_{12}H_{11}$) by the same treatment of Capric Acid [Hirciric hydristyle] and of Œnanthylic Acid [Œnanthiric hydristyle]. In these hydristyles, however, the Thyles in question are obviously neither basic nor stylic: they form part of the stylic member, constituting, with the addition of C_2, the antibasic molecule of these bodies.

* The notions of this analogy which are presented to students are occasionally somewhat vague. Thus, in the only Handbook of Organic Chemistry yet finished—it cannot be said completed

accept the adhesion of epistyles for the complication of their stylic member, and can be made to exchange their Oxygen for other halogens. Further, as we shall see hereafter, they confer upon some of their compounds with the halogens certain properties precisely similar to some which the acids enjoy by virtue of their hydrogen.

235. It is maintained by those who accept the unitarian theory of M. Gerhardt, that as water is, according to them, not a bi-polar compound H:O, but $\left.\begin{matrix} H' \\ H' \end{matrix}\right\}$O, tri-polar, so the oxythyles are similarly tri-polar. Thus Ether is, according to them, $\left.\begin{matrix} C_2H'_5 \\ C_2H'_5 \end{matrix}\right\}$O. That this is a correct representation of the constitution of ether is supposed by the unitarians, and even by many who do not ac-

Ether is probably C H, O.

—in our language, the learner is informed that in a certain point of view the Ethyloids differ from Hydrogen, namely in that "while the oxide of Hydrogen is neutral, that of the Methyle is basic" (p. 159). This is assuredly incorrect, whatever sense be given to the words "neutral" and "basic:" the latter term cannot be intended here to express any other capability than that of combining with epistyles. Bodies so endowed I should call stylobasic. But water is quite as decidedly gifted with this property as is any Etheroid oxybase. By virtue of this property, water forms complex hydrostyles, while the oxythyles form complex thylistyles. It is exerted with less tenacity by water than by its carbonous homologues, but these are certainly inferior to their prototype in the readiness with which they accept their epistylic adjuncts. So again, in whatever sense water is neutral, the oxythyles are certainly neutral too. All the latter are, equally with the former, bland and devoid both of acid and of alkaline ardour. In short, the truth is, that, like the Oxide of Hydrogen, that of Methyl is both neutral and prostylobasic.

cept their theory, to be proved by a very interesting discovery of Mr. Williamson, which I shall presently notice.* I shall then endeavour to show that the facts to which I allude need not at all disturb the old belief that the Oxythyles are truly of the same form with the other Thylistyles, and that Ether is $C_4H_5:O$.

Basic energy of the Thyles unascertained.

236. As for the basic energy of the Thyles, as respects their strength, it is extremely difficult to institute a comparison of them, even with Hydrogen, which they most resemble. Some facts would certainly seem to indicate that Methyl and Ethyl are stronger bases than Hydrogen. The former bodies are expelled from their salts less easily than is the latter by metallic bases. Again, the oxide of Ethyl at least forms, though indirectly, a permanent compound with the weak epistyle CO_2, which H:O does not, and the assumption of epistyles by salts is certainly an indication, though it may not be a measure, of unsatisfied basicity. Under certain circumstances, which we shall have to notice hereafter,† Ethyl will expel Hydrogen from its basic place by interchange; though again, under other conditions, in which the same compound is concerned, Hydrogen will supplant Ethyl in the same position. The dignity of the thyles in the scale of bases cannot be said to be as yet ascertained.

Inertness to decomposi-

237. The behaviour of the Thylistyles towards

* See § 251, p. 244.

† P. III. Ch. V. sect. 7, div. ii.

ther salts is certainly different, in a remarkable manner, from that of the analogous combinations of Hydrogen and of the metals. Their inertness under the ordinary methods of aqueous chemistry seems at first sight to place them in a category quite different from that which includes our common acids and salts. It is difficult to believe that the basic molecule of oxybases, which show no great avidity for interchange of halogens, or for annexation of epistyles, and which yet refuse to be expelled at once from their basic seat by metals of great positive energy, can be united to their oxygen by any such attachment as that which binds Hydrogen and Potassium to Oxygen in H:O and K:O.* But much of this difficulty vanishes if we remember that, by the oily nature possessed by nearly all of these bodies, and which they owe to the carbon, which forms so large a part of their structure, they are as effectually removed from the sphere of actual aqueous chemical action as a substance can be by precipitation in the solid pulverulent form, or even more so. This tendency to oiliness is doubtless indicative of the action of peculiar forces within the substances so affected; these new forces may mask the action of others which operate within the same matter, but do not necessarily extinguish

tion results from oily nature of Thylistyles.

* An interesting illustration of the peculiar condition of basicity, which is affected by the Thyles, is afforded by the compounds formed by Mr. Railton, in which Ethyl and Amyl are substituted in Phosphorous [Phosfiric] Acid for a molecule of Hydrogen which is not replaceable by the stronger bases. See note to § 103, p. 81.

them; indeed, the more we learn of these carb
nous thylistyles, the more reason we have for be
lieving that they are bipolar systems held togethe
partly by the same force by which the sympoles o
all true salts cohere. We have already learnt tha
many decompositions, which we could not obtai
from them under ordinary circumstances, can
readily under higher temperature and pressur
Perhaps we may yet find methods of renderin
these bodies conductive of the voltaic force, and
inducing such of them as are truly bipolar to sp
into their two members under its solicitation.

2nd. Thyles as "bodies."

238. The next point to be noticed is the natu
of these bases as respects isolability. We ha
already seen that, of the stylic members of sal
there are, besides the elementary Halogens, scar
ly any which can be produced in the free st
Cyanogen and Mellone being the only compo
stylic bodies hitherto obtained. We shall find t
on the basic side of salts a similar but rather l
rigorous rule prevails. There is a vast numbe
complex bases, but of these very few have sho
any signs of separate existence; and we have ev
reason to believe that the general rule among th
is, that they are incapable of isolation. Am
the few complex bases that are believed to h
been obtained in the free state are some of th
Thyles whose oxides we have already mentio
We owe to Kolbe and to Frankland the produc
from certain Thylistyles, if not of the actual b
Thyles, at least of certain bodies possessing

e proportional composition. These remarkable
overies are so fresh in the recollection of che-
s,—for whom anything called a "radical" has
nigh an interest, either as a treasure to be
ched at, or as an object of the most jealous scru-
,—that they need scarcely be more than men-
ed here. But, for form's sake, the reader may
reminded that the eminent chemists just men-
ed formed a gas having the composition C_2H_3,
ch they supposed to be Methyl, by the action
Potassium on Cyanide of Ethyl ($C_4H_5:C_2N$).*
imilar compound was afterwards eliminated by
be in the voltalysis of Acetic [Acetiric] Acid.†
nkland afterwards, by the action of Zinc on
de [Iodade] of Ethyl ($C_4H_5:I$), obtained a
ture of gases, among which was one apparently
same as this, that is to say, Methyl, and an-
r having the composition of Ethyl (C_4H_5).‡
same chemist again separated this body (C_4H_5)
i its Iodide by the action of solar radiation,
d by the presence of Mercury.§ He also, by
:ing Amyl-iodide ($C_{10}H_{11}:I$) with Zinc amal-
, obtained, together with some other hydro-
on liquids, a volatile compound having the
position $C_{10}H_{11}$.‖ Finally, Frankland con-
ed that there are two series of Hydro-carbons
he form C_nH_{n+1}, the molecular weight of each

* Journal Chem. Soc., vol. i. p. 65.
† Ibid., vol. ii. p. 183. See a note in P. III. Ch. V. sect. 2.
‡ Ibid., vol. ii. p. 275.
§ Journal Chem. Soc., vol. iii. p. 332.
‖ Ibid., vol. iii. p. 32.

member of one being double of that of the isomeric one in the other series, and that some of the compounds resulting from these processes belonged to one of these types, being the true bases or "radicals," while the others were of different constitution.* The opinions of chemists are still divided as to the nature of the compounds thus obtained; it is contended, against the bases or "radicals," that the molecules of the actual bases are in every case doubled in the act of their liberation; according to some reasoners, because, *à posteriori*, these products do not behave as true bases should; according to others, because, *à priori*, they ought to be dimerized as they escape from combination. It is admitted by their defenders that they do not, when free, show any signs of the basic attachment which holds them with such remarkable tenacity when they are once united to their sympoles.† The question which has been thus discussed with respect to the new compounds has been, whether they are or are not the actual "radicals." I do not think this inquiry can meet with any very satisfactory answer. The important point is, are they bases? If so, are they the bases of the actual salts from which they were derived? The basicity of a body certainly admits of being ascertained. Every base will certainly combine with some style

* Journal Chem. Soc., vol. iii. p. 341.

† The reader will find a summary of these arguments, with references to the original papers, in Liebig's 'Annual Report of Chemistry,' Eng. Trans., vol. iv. p. 235.

other, if not with every halogen. It may unite gerly or even readily with any such polar mole- le; but there must be some circumstances under ich it may be induced to pair with its opposite, herwise it is no base. But certainly its non- sicity cannot be asserted till all known means of tting the bonds upon it have been tried and have led. A complex basic molecule might certainly ffer substitution of Chlorine for some of its Hy- ogen rather than form a true chloride by combi- tion; this might arise from the instability of its ructure, and from the great tendency to the for- ation of H:Cl. Such a reaction cannot disprove basicity. The occurrence on the other side of the lt system, of the isolable complex styles Cyano- n and Mellone, would lead us to expect the for- ation of some free complex bases; while at the me time the rarity of the former class of com- unds would incline us to suppose that the latter uld not be very numerous. Again, we certainly ow a few complex isolable bases, of constitution fferent from that of these simple Thyles; so that e *à priori* improbability of their separation is t so very great, especially when we consider that e analogy in function of these hydro-carbons to drogen, which is so easily set free, is much closer an that of any other complex molecules that we e acquainted with. On the other hand, it must remembered that these Thyles adhere very rongly to the Halogens, and to other stylic mole- les, when once united to them; and that in all

known instances of isolable bases, the readiness of their combination with styles seems to be proportional to the energy of their attachment when so united. So that though Hydrogen, Gold, and Platinum are examples of bases towards one end of a scale about the other end of which lie Potassium, Sodium, etc., yet the former, which are far more easily detached from their saline combinations than are the Thylic bases, seem to be much exceeded by these new compounds in the inertness of their basic combining energies. I think that some further facts are required to enable us to assert without doubt that any of these Thylic bases have actually been isolated, and to warrant us in expecting that all of them will be obtained in the free state.

3rd. Thyles as complex systems.

239. Finally, we have to consider the constitution of these thylic molecules. With respect to the greatest number of them, we have not much information that would help us to a conclusion on this head. But the compounds of Ethyl have been so diligently examined, and their habits are so decided, that we have more materials for a rational inference as to its structure; and with the footing so obtained, we may reach by analogy to a tenable notion as to the nature of its congeners. The production of Olefiant gas (C_4H_4) from the compounds of Ethyl under certain reactions is, I conceive, a very significant phenomenon. This has, as every one knows, is separated from Alcohol by heating it with an excess of oil of vitriol. Again, Hofmann observed that each of his Alkalies,

$\underline{(C_4H_5)_3,N;C_4H_5\dagger O}$ ..., $\underline{(C_4H_5)_3,N;C_{10}H_{11}\dagger O}$. $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\C_{10}H_{11}\end{matrix}\right\}$ $\underline{,N;C_2H_3\dagger O}$
H ⋮ O H ⋮ O H ⋮ O

when heated, evolve C_4H_4.* Each of these actions consists obviously in the division of basic Ethyl (C_4H_5) into two parts, namely into H, which remains attached to the Stylic O, forming water, and C_4H_4, which escapes. In the cases of these new Alkalies, nitrogenous molecules, analogous to Ammonine, are also separated; and in the two latter instances, the C_4H_5 seems, before its own decomposition, to pass, by interchange, from its original position of union with the Nitrogen to that of a base, as respects the Oxygen of the system. This transposition seems to arise from the greater instability of the particles of Ethyl as compared with its congeners. Now these facts cannot be so well explained by any other theory, as by supposing that Ethyl is in reality C_4H_4,H; and that Ether is $C_4H_4,H:O.$, in fact, water, in which Olefiant gas is annexed as an adjunct to the basic H. According to this view then, Ethyl and its thylic congeners are constructed on the same plan which seems to prevail so generally in the system of Salts, namely that of modifying the form of the members, by the ingrafting of other molecules upon them, without altering their position in the compounds. This notion is strengthened by the fact that others of the Alcohols yield, by dehydration, corresponding hydro-carbons, homologues of C_4H_4; while

* Phil. Trans. Part 2, 1851, pp. 366, 375, 380. See a note in P. III. Ch. II. sect. 2.

members of the same series have been ob-
...d in other reactions. Thus Hofmann found
his Alkali $\frac{(C_{10}H_{11})_3,N;C_{10}H_{11}\dagger O}{H\ \ \ \ \ddagger O}$ yields, under
neat, beside the com... $(C_{10}H_{11})_3N$, a hydrocar-
bon, as to which there ...arcely be any doubt that
it is the "Amylene"* ...$_{10}$); and Frankland† ob-
tained a body, having ...me composition, among
the products of the a... Zinc on Iodide of Amyl
$(C_{10}H_{11}:I)$. Again, it ...pears that, in a few in-
stances, salts have been ...und containing thylous
bases in which a metallic molecule has been substi-
tuted for a single atom of H. Thus we have the salts
$\frac{C_4H_4;Pt\dagger Cl}{Pt\ddagger Cl}$‡ and $C_2H_2;Ag:O;C_{14}\left\{\begin{matrix}H_3\\(N\ O_4)_2\end{matrix}\right\},O_5$.§
In these it seems probable that the hydrocarbon
molecules C_4H_4 and C_2H_2 are appended as adjuncts
to the metals Pt. and Ag. respectively. And in
the ordinary thylous salts, the same molecules are
most likely annexed in a similar manner to basic

* Phil. Trans. 1851, Part 2, p. 289. It appears however that the Alkali $(C_2H_3)_3\frac{N;C_2H_3\dagger O}{H\ \ \ \ \ddagger O}$ does not suffer an analogous decomposition, not evolving C_2H_2 (Phil. Trans. p. 383). Dr. Hofmann informs me that he ascertained, by a subsequent hitherto unpublished experiment, that this Alkali splits, under heat, into $\frac{(C_2H_3)_3N+C_2H_3\dagger O}{H\ \ \ \ \ddagger O}$. It would seem that, under these, as under certain other conditions, methylic Alcohol is more stable than its ethylic congener.

† Qu. Journ. Chem. Soc., vol. iii. p. 44.

‡ See a note to P. III. Ch. III.

§ See note to P. III. Ch. V. sect. 7. div. ii.

Hydrogen. The lowest member then of this series of thylic molecules, Methyl (C_2H_3) may be written $C_2H_2,H.$; and since the adjuncts of all the members of the series are multiples of C_2H_2, we may reasonably write them thus:—

Ethyl $C_4H_4,H=(C_2H_2)_2,H$ .....
Amyl $C_{10}H_{10},H=(C_2H_2)_5,H$ .....

Section II.

Of the Relation of certain Double Salts to Alcohol.

240. Now we have seen that water is the Archetype to which we must compare a large class of compounds, which may be said to be waters, each modified by the conjugation of a complex molecule, Zoogenic or of other denominations, to their Oxygen. It is equally certain that there are a great number of other bodies, likewise referable to water as their prototype, but differing from this first kind in that, in them, not the Style but the Base-member of the water, is complicated in an analogous manner. The former are complex Hydro-styles, more or less energetic; the latter are complex Oxybases, of greater or less potency: that is, as respects their alkalinity, these are Salts having Oxygen for their Halogen, and, as respects their complexity, waters modified by the conjugation of complex molecules, Zoogenic and of other denominations, to their Hydrogen. To this class of compounds, then, I conceive that the Oxythyles belong. Closely allied to these are certain bodies of doubt- Nature of the Oxythyles.

ful constitution; bodies which seem to be anti
of water, yet with respect to which it ma
doubted whether the complicating molecule
most always of Zoogenic structure, are appe
to the Basic or to the Stylic side of the a
typal compound. With respect to some of
bodies it would be doubtful, even if it wer
monstrated that their Zoogenic member lies w
on the Basic side, whether they are truly
complex salts, and not rather "double salts"
sisting of normal water coupled laterally wi
homologous body, in which latter the Hydro
the water has conjugated to it, or is replac
some complex molecule. With reference to
bodies, when the place of their hydrocarbo
been shown to be certainly on the Basic side,
will also be this residual alternative, that it w
open to the "unitarians" (until their view c
constitution of water* has been disproved) to
tinue to represent them as being Waters in
half the Hydrogen has been replaced by a co
molecule.

Is Alcohol a single complex or a double salt?

241. Alcohol is a type of this doubtful cl
compounds; Ether too and its homologues
for the sake of argument, be considered as of
lary dubious nature. I have already classed
among the single bipolar bodies, but since
high authorities maintain that it is of dif
form, it is necessary to admit the doubt fo
purpose of examining it.

* See § 45, p. 32.

242. Much theory and discussion have been be- Various views of constitution of Alcohol.
owed upon these bodies. Some chemists prefer
"consider" Alcohol as an acid, which would be
presented thus, $H:O;C_4H_5,O$; others "consi-
er" it as an Alkali, that is as a salt analogous to
ater, having a single atom of Oxygen for its style,
us: $C_2H_5:O$; while the more usually accepted
tion of its being hydrated Ether is really ambi-
ous, leaving it in doubt whether it is a single salt
th a complex style, having Ether as its Prostylo-
e and water as its epistyle, thus, $C_4H_5:O;H,O$,
"Double salt" of water coupled with Ether,
us, $\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}\overline{O}$; and more recently, arguments have
n brought to show* that it is water in which half
Hydrogen is replaced by Ethyle (C_4H_5 or $C_2H'_5$),
s, $\left.\begin{matrix}C_2H'_5\\H'\end{matrix}\right\}O$.

243. Now part of this discussion might have Is Alcohol an antitype of water?
n spared, if a satisfactory answer could have
n obtained to one chemical experiment. There
two chief points in dispute with respect to
se bodies and their similars, especially with re-
ct to alcohol. One of these questions logically
cedes the other, by such absolute necessity,
t the second ought not to have been broached
ll until the first was settled. The first is this:
alcohol a body of the aqueous type at all?
t is to say, is it, like water, a bipolar body,
sisting of two members, held together by the

* Williamson in Qu. Journ. Chem. Soc., vol. iv. pp. 106, 229.

o-basic attachment? If not, that is to say,
hol cannot be voltalyzed* by any contrivan
must give up at length, however reluctant
close comparison thereof with water, and
attempts to represent it by any such formula
belongs to single . If, however, our favour
spirit should yet s nit to the voltaic analys
our question becomes On which side of the co
pound does the ocarbon molecule lie?
as would mos a ly be the case, this imp
tant part shoud b und to lie on the Basic
Volta-positive side (and so escape with Hydrog
at the cathode), then to "consider" Alcohol†
an acid, a Salt having Hydrogen for its base,
simply an error. When this point shall be fai
settled, we shall be, for the first time, in a p
sition to enter on the second question, which
this: What position does the peculiar hydrocarb
group of Alcohol occupy with respect to the ba
Hydrogen of normal water? That is to say,
may then inquire whether $C_2H_3:O$, or $H_2C_2;H:$
or $C_4H_5:O;H,O$, or $(H_2C_2)_2;H:O;H,O$,
$\frac{C_4H_5 \mid O}{H \mid O}$, or $\frac{(H_2C_2)_2;H \mid O}{H \mid O}$, or $\left.\begin{matrix} C_2H'_5 \\ H' \end{matrix}\right\} O$. be t
truest approximation to a graphic delineation
Alcohol.

* The attempts which have been made hitherto to volta
Alcohol have only yielded negative results. The reader will
them digested in Gmelin's 'Handbook.'

† In a certain sense it is unquestionably true that Alcohol i
acid, and Mr. Williamson urges very justly (Qu. Journ. Ch
Soc., vol. iv. p. 237), that if an acid is defined by the circ

244. I have no intention of attempting to de- Alcohol a double salt not disproved by Mr. Williamson.
de this question here; but assuming for the pre-
nt that the Hydrocarbon lies on the basic side of
lcohol, I wish to remind my readers that the same
autiful experiments by which Mr. Williamson has
tempted to support the last of the above formu-
, may be taken as equally cogent arguments in
vour of either of the two formulæ immediately
receding that one in my list. These two formulæ
present Alcohol as a double salt, in which true
ater is coupled with an analogous body, having
complex base containing five equivalents of Hy-
ogen and four of Carbon.

245. In discussing the nature of double salts, as Is Potash a double salt?
nnected with single salts having a complex style,
mentioned one question of considerable import-
ce as involved in this inquiry, namely, what is

nce of containing hydrogen replaceable,—not by metals or dicals generally, as he states it,—but by other bases, we must nsider Alcohol as acting the part of an acid. But this is only e in so far as water is an acid. The experiments on which he ounds the comparison prove nothing more than that the water Alcohol acts as an acid, exactly as free water does; they do t indicate in the least degree that Alcohol is an acid in the same se in which Acetic Acid is, which he goes on to infer. His re-lts, on the contrary, confirm the belief which before we had every son to hold, that in Alcohol the Hydrocarbon is basic; whereas lbe has shown, that in Acetic (Aceturic) Acid, just as in Sul-ic (Sulfuric) Acid, the hydrocarbon lies on the volta-negative le, being antibasic. There are the strongest grounds for sup-ing that in the acetification of Alcohol another most important ndition is concerned, besides the oxidation of the compound, mely, the transference of the residual Hydrocarbon from the sitive to the negative side of the system.

the construction of the so-called "Hydrate of P[o]tassa?"* This is altogether left in obscurity [by] the current theory of chemistry at present, whi[ch] makes no approach to illustrating it. Now th[is] question has for us a still further interest, whi[ch] is due to its bearing upon the formula of alcoho[l] about which, as we have seen, there is a precisely similar dubiety.

or a "Hydrate?"

246. I think that there are no reasons for adopting the unitarian formula $\left.\begin{matrix}K'\\H'\end{matrix}\right\}O$ for the simplest compound of Potassium and Hydrogen with Oxygen, and that the question here lies only between the figures $\begin{matrix}K\\H\end{matrix}\Big|\begin{matrix}O\\O\end{matrix}$ (Kal-hydr-oxede), and K:O;H,O (Oxyhydrate of Potassium, or Kali-hydrate), or about some intermediate form.

Discussion of the different formulæ for Alcohol

247. The substances corresponding to this "hydrate," but containing Hydrocarbon groups instead of Hydrogen, are the bodies which here claim our attention. The compound of this kind, constructed by adding Potassium to Alcohol, has, according to Mr. Williamson, the formula $\left.\begin{matrix}C_2H'_5\\K'\end{matrix}\right\}O$, Alcohol being represented by him as $\left.\begin{matrix}C_2H'_5\\H'\end{matrix}\right\}O$. These formulæ divested of the peculiar notation in which he has dressed them, become $\left.\begin{matrix}C_4H_5\\K\end{matrix}\right\}O_2$, and $\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2$. And the questions now are:— firstly, shall we accept the unitarian theory and

* See §§ 167, 168, p. 152.

formulæ as applied to these bodies, or shall we represent them by the old notation? Secondly, if we adopt the old notation, under which the above forms are ambiguous, shall we write these bodies as $K:O;C_4H_5,O$, and $H:O;C_4H_5,O$, or as $\frac{K\dagger O}{C_4H_5\dagger O}$ and $\frac{H\dagger O}{C_4H_5\dagger O}$, or (with respect to the latter of the two, since the alternative of antibasicity cannot apply to the strong base of K) $C_4H_5:O;H,O$, or shall we adopt one or other of these formulæ? substituting $(C_2H_2)_2,H$ for C_4H_5? or finally, since the coefficients of each element in the formulæ for the second of these bodies, are all even numbers, shall we divide them by two and write it as $C_2H_3:O$, or $C_2H_2,H:O$? I suppose that no one will be found hardy enough to suggest for Alcohol such a formula as $H:O;C_2H_3$, so that alternative need not be considered.

rendered difficult by Alcohol not having been voltalyzed.

248. Now, with regard to the proposed unitarian formulæ just cited, no contradiction to ascertained truth is involved in them, because, since these bodies have not been voltalyzed, we do not know that the hydrocarbon group does not lie on the basic side of the compounds. We do not know that C_4H_5 does not replace Hydrogen in these compounds, but rather have strong reasons for supposing that it does. We must not therefore, in this instance, as we did in the case of Acetic and other Acid,* reject these new formulæ as not concordant with fact. But we may pass them by for

* See § 138, p. 121.

two reasons, firstly, because there is no *à pr*
probability of their truth, since the other form
of this kind which we have encountered,
which we are told are put together on the s
principles, are manifestly untrue; secondly,
cause whatever explanation they may give of
phenomena, these latter are equally accounted
by the ordinary notation, and that with a
higher degree of perspicuity and precision.
accepting the "unitarian" formulæ we lose all
actitude, as well as possible expression of t
kind of variety in position which we have
to be admissible as respects the constituent
double salts;* while with the other formulæ
only danger is, lest, by affecting too great an
difference to all acquired truth, we commit
error of asserting too much. I therefore dec
to discuss here the first question, namely that
tween the two kinds of notations, and shall
handle the second question, namely that of
different formulæ under the old notation, and
with an express view to the avoidance of the ab
mentioned error.

Results of Mr. Williamson's experiments discussed.

249. Now, what light as to the constitutio
these questionable bodies, "Hydrate of Potas
Alcohol, and Potassium-Alcohol, do we ob
from the experiments of Mr. Williamson on E
rification?† The first point is, that Potass

* See §§ 159–169.

† Phil. Mag. s. 3, vol. xxxvii. p. 350; Qu. Journ. Chem.
vol. iv. p. 106.

o Alcohol produces a body analogous to the ate of Potassa" (of Potassium), forming ink between that compound and Alcohol, k in which the Hydrogen of the former o be replaced by C_4H_5 (Ethyl), or in which n of the Hydrogen of the latter is replaced ssium. Now this fact confirms, though it be said to demonstrate, the truth of our hat Alcohol is constructed on the stylobasic and that its hydrocarbon group lies on its positive side. Next it suggests to us, with a that is almost convincing, that these three are all formed upon the same type, so that t consists of water, in which half the Hy- is replaced by Potassium; that the second of water, in which half the Hydrogen is eplaced by, or has annexed to it, a complex le of Carbon and Hydrogen; and that in the e two halves of the Hydrogen of water con- are both thus disposed of, each according of these changes. The number of water les that are involved in the formation of one le of each of these compounds, is the point ute between the unitarian and the vulgar s. Thus far nothing can be inferred from nomena, to favour the belief that it is the of the Hydrogen of a single equivalent of hat suffer these changes, rather than that laced or conjugated Hydrogen is the whole gen of a certain proportion of integral water, by union with another equal quantity of

water, forms a multiple salt. So we may logi
deal with our ordinary symbols alone, which co
the simpler notions, and may adopt the simp
conception which these or any other symbols
embody for us, namely that the two equal port
of water concerned are each a single atom or
mical unit, and that consequently the compo
resulting from their coalition is a double
Now since we conclude that the three bodie
of the same type, we must reject any repre
tation of any one of them, the form of whi
quite inapplicable to the others. We discard
$C_2H_3:O'$ and $C_2H_2,H:O$ for Alcohol, since n
rallel formulæ can be suggested for the othe
compounds. So that the question now re
narrowed to that of the particular kind of t
salt to which they belong. Are they of the g
form $\equiv|\equiv$, or of $-|- -|-$,* or of an interm
configuration?

Different types of the compounds of C_2H_4.

250. I have already shown grounds of pr
lity for the belief that the "Hydrate of Pot
approaches to the nature of a complex salt
form $-|- -|-$, involving its water as an e
[Hydrare]. If this is the case, and the three
are constructed on the same type; the othe
we should say, must also be of this form. But
so certain? By no means. It does not at all
that the water or its substitute shall occu
same position in all three. Because, as I ha
deavoured to show, if the water in the al

* See § 157, p. 142.

e does act as an epistyle, this position is due deep basicity of the Potassium, not the high icity of the Hydrogen. And, according to nciples which I have suggested with respect onstitution of double salts, when, in a double e base is replaced by another, the relative po- f the two salts in the compound is probably ined by the comparative powers of the bases; r words, the different forms —|— —|— and re both of the same type. So that, though npound having for its bases Potassium with gen, may be of the form —|— —|—, and to be as K:O;H,O, yet the other two cognate having "Ethyl" (C_4H_5, or $(C_2H_2)_2$,H) with gen, and Potassium with Ethyl, for their ive bases, may be of the form =|=, and written $\frac{C_4H_5 \cdot O}{H \cdot O}$, and $\frac{K \cdot O}{C_4H_5 \cdot O}$, or perhaps e disposed according to some intermediate such as —|=|—. In arriving at a conclusion head, we can only be guided by any light we ave as to the relative basicity of H. and of The deportment of the compounds of Ethyle to indicate that the basic energy of this com- olecule is greater than that of simple Hy- , though vastly inferior to that of Potas- According to this, without attempting to any greater degree of precision, we should ranted in writing our two latter compounds $\frac{H_5 \backslash O}{H \backslash O}$, and $\frac{K \backslash O}{C_4H_5 \backslash O}$; or, further refining

these, according to an analogy which I have already indicated,* and to other analogies which I shall have to point out, as $\frac{(C_2H_5)_2H\cdot O}{H\cdot O}$ and $\frac{H\cdot O}{(C_2H_5)_2H\cdot O}$.

Ether, and views of its constitution.

§ 241. From some further highly interesting facts elicited by Mr. Williamson, some important inferences have been drawn as to the constitution of Ether. This point, to which I have already alluded,† now claims our examination. Williamson has shown, that by treating the body represented by the last of the above formulæ (Potassium-Alcohol) with Iodide [Iodide] of Ethyl (C_4H_5:I, or $C_2H_5'I$), Ether is produced. Now the suggested formulæ of Ether, with respect to which there is question, are C_4H_5·O, or $(C_2H_5)_2$H:O, and, according to Mr. Williamson, $\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$, which, being translated into the usual notation, must be written $\frac{C_2H_5\cdot O}{C_2H_5\cdot O}$, or $\frac{(C_2H_5)_2H\cdot O}{(C_2H_5)_2H\cdot O}$. Here we must examine the merits of the new formulæ, for it does not contradict any ascertained fact, and it is supposed to be supported by the next point which is to be adduced, namely that by treating Potassium-Alcohol with Iodide of Methyl (C_2H_3:I, or $CH_3'I$), a body is obtained which, Williamson considers, must of necessity be written according to his method. He holds this position because it contains an equivalent of Methyl

* See § 239, p. 233. † See § 235, p. 224.

with an equivalent of Ethyl, both of which represented in the formula; and this, he effected in the simplest manner by the symbols, thus, $\left.\begin{matrix} C_2H_5 \\ CH_3 \end{matrix}\right\}O$. Therefore, he the analogous result of the action of Iodide e must be represented in the same way, so fact, an atom of Ether is an atom of water each half of the Hydrogen is replaced le. Now this last formula, translated into mical vernacular, becomes $\frac{C_4H_5\uparrow O}{C_2H_3\downarrow O}$ or $\frac{H\uparrow O}{H\downarrow O}$; that is to say, a double salt, con- f two atoms of water, in one of which the placed by C_4H_5, or has conjugated to it while in the other the H. is replaced by has conjugated to it (C_2H_2).* This no- he double salt is elegant and clear, and in harmony with all our hitherto observations; ong as we can retain such a notion of the nd, we need not give it up for the new one by the unitarians. For we have every or supposing that C_4H_5 and C_2H_5 not only he basic side in their compounds, with Iodine, etc., but constitute by themselves

orth remarking, that these new Ethers are precisely o "Anisole," $\frac{C_{12}H_5\uparrow O}{C_2H_3\downarrow O}$, and Phenetole, $\frac{C_{12}H_5\uparrow O}{C_4H_5\downarrow O}$, which Alcohol $\frac{C_{12}H_5\uparrow O}{H\downarrow O}$, with Methyl and Ethyl respec- ituted for its basic Hydrogen. See note, p. 261.

complete (not necessarily isolable) bases, fully equivalent to Hydrogen. And we have no reason for supposing that the halves of these bodies, namely, C_2H_5' and CH_3', are separable bodies corresponding to H′., the half of H. And whatever grounds justify the substitution formula of the unitarians, warrant us, it is admitted, in assuming that of the double salt.

especially as deduced from his compound Ethers.

252. But it is argued in support of the unitary conception, that whatever is the constitution of the double Ether, produced by the second operation with Methyl-Iodide, the same must be the constitution of the first Ether, produced by the Ethyl-Iodide; for that they are produced in the same way; and that so, if the double Ether be a double salt, single Ether must be such likewise, and must be written $\frac{(C_2H_2)_2;H}{(C_2H_2)_2;H}\Big\uparrow O$, or $\frac{C_4H_5}{C_4H_5}\Big\uparrow O$, or $C_8H_{10}O_2$, which is a very complex formula. Again, it is said, on the other hand, if this be not the constitution of the Ether obtained from the Ethyl-Iodide,—but if two separate molecules of Ether are produced in this reaction, each of which is $C_4H_5{:}O$, or $(C_2H_2)_2H{:}O$, one deriving its Ethyl from the Iodide, the other from the Potassium-Alcohol,—then two separate molecules of different Ethers ought to be obtained by the second process, one containing the Methyl of the Iodide, the other the Ethyl of the Alcohol.

This analogy disputed.

253. Herein I think lies a fallacy. It does not at all follow that because two different but analo-

Thus compounds, when formed side by side, should, in the nascent state, unite to form a double salt, which we are entitled, on the part of the old formulæ, to hold to be the rationale of the phenomenon,—that therefore two molecules of the same body, when formed side by side, shall become polymerized or dimerized into a compound of double equivalent weight. Such a synthesis of similar particles undoubtedly occurs in some peculiar cases; but they may, and may usually be expected to, remain asunder, similar to each other, and each with its ordinary chemical value. Now we may fairly say that two molecules of simple Ether are formed side by side in these experiments, and we need not admit that one molecule of double Ether must be formed, by substitution, in a system already fixed. For, according to the enlarged view of the constitution of double Salts, which I have endeavoured to show to be reasonable, the water [Hydrare?] in the compound K:O;H,O would, on the withdrawal of the base Potassium by a more powerful halogen, such as Iodine or Chlorine, lose its place as an epistyle, so that the stable equilibrium of the system of the double salt being broken up, the proximate molecules would move upon themselves to assume a new position, which would be determined by the positive energy of the new base introduced, and in this movement may be detached from each other altogether. Thus, in treating a boiling solution of K:O;H,O with Ag:Cl we obtain K:Cl and Ag:O, not Ag:O,HO,

because the attachment of Ag:O as a prostyle base is not sufficient to retain the H,O as an epistyle. Similarly, on treating K:O;H,O with HI we obtain K:I and two equivalents to H:O, not H:O;H,O, or $\frac{H \uparrow O}{H \downarrow O}$. We have no reason for supposing that the two molecules of HO remain coupled together in any new form. Now many oxybases will effect a double decomposition with Iodide of Ethyl;—for instance, Oxide of Silver, in the presence of water. Alcohol and Iodide of Silver are formed,* when these two bodies act

* Hofmann, Phil. Trans. 1851, Pt. II. p. 371. In this same treatise (p. 366) Hofmann records a very interesting reaction, which he takes to be confirmatory of the failure of the analogy between C_4H_5:I and C_4H_5:O. He informs us that his "hydrated oxide of tetrethylammonium," $\frac{(C_4H_5)_3,N;C_4H_5 \uparrow O}{H \downarrow O}$, splits up under the influence of heat into "triethylamine," $(C_4H_5)_3,N,+C_4H_4+2(H:O)$; whereas the corresponding Iodide yields under similar treatment $(C_4H_5)_3,N+C_4H_5:I$. This reaction may be cited as forming at least equally strong evidence against the unitary theory of the constitution of Alcohol, on which the new theory of Ether depends. For, according to the unitary notation, we have here precisely the molecules that are necessary for the formation of Alcohol, yet Alcohol is not produced. Thus we might expect under the new theory to find

$$(C_2H_5')_3,N';C_2\left.\begin{matrix}H_5'\\H'\end{matrix}\right\}O=(C_2H_5')_3N'+\left.\begin{matrix}C_2H_5'\\H'\end{matrix}\right\}O.$$

But this result is not yielded. The inference from this experiment seems to me to be, that Ether (C_4H_5:O) is a conjugated water, thus, C_4H_4;H:O, and that the adjunct C_4H_4 which is annexed to its H. (see § 239, p. 230) is here loosed from its attachment, perhaps by the adhesion of the separating "triethylamine." I must state however that Dr. Hofmann informs me,

on each other. Now this reaction, under the tary view, can only appear as a very complicated ir;—thus,

$$2(C_2H_5':I') + \left.\begin{matrix}Ag'\\Ag'\end{matrix}\right\}O + \left.\begin{matrix}H'\\H'\end{matrix}\right\}O$$
$$= 2(Ag':I') + 2\left(\left.\begin{matrix}C_2H_5'\\H'\end{matrix}\right\}O\right);$$

riple interchange must be supposed to take place tween the two Oxides and the Iodide. The binary otation represents this as a very simple matter; hus, $C_4H_5:I + Ag:O + H:O = Ag:I + \frac{C_4H_5}{H}\Big\}O$.

The Oxide of Ethyle here seems to escape isolation only because in the nascent state it has, like K:O, a very strong attachment for H:O. But even water itself, under certain conditions, will effect this direct exchange of Kalogen with this compound (Ethyl-Iodade), and that in a more simple manner, without the formation of the Diplohale-Alcohol. The following fact, stated by Frankland (Qu. Journ. Chem. Soc., vol. ii. p. 291), is a strong evidence in favour of the belief that the oxides and the iodides of Hydrogen and of Ethyl are constructed on the same type. "Iodide of Ethyl and water, heated in an hermetically-sealed tube, are trans-

that he has found by some hitherto unpublished experiments, that the oxide of "tetramethylammonium" does produce methylic Alcohol, together with "trimethylamine," when subjected to dry distillation. Hofmann supplies us with another instance in which the duplication of similar molecules must be supposed to take place, if it happens in the case of Ether, but in which it does not appear to ensue. (Qu. Journ. Chem. Soc., vol. ii. p. 317.)

formed into Ether and a concentrated solution
Hydriodic Acid." The formation of the do
compound $\frac{C_4H_5}{H}\Big\}O$, which occurs in so many c
and which marks the analogy between C_4H_5:I
C_4H_5:O, is here probably prevented by the
temperature. So that here we see the direct i
change, which cannot be represented in any
way so simply as by the equation C_4H_5:I+
$=C_4H_5$:O+H:I.

No probability of the molecule of C_4H_5 being coupled.

254. Precisely according to this analogy, we
not the smallest reason for supposing that on
ing $\frac{K}{C_4H_5}\Big\rangle O$ with C_4H_5:I, we should obtai
two resulting molecules of C_4H_5:O couple
gether at all; although if they were molecu
different oxybases they might, and, as we
Mr. Williamson's experiments, do, remain at
to each other. It is most likely that there
be cases analogous to that of the treatm
K:O;H,O with AgCl, in which the two re
oxybases, with different complex zoogenic
would remain permanently separate, like the
and H:O, without the formation of a doub
or Ether. However, throughout all natu
law is, that similars remain asunder, diss
unite. We find this law obeyed by magnet
trics, sexes; it probably prevails also among
chemical.

Etherification explained.

255. According to this view, the highly in
ing process of Etherification may be a very

resolving itself into the successive union and ance of the constituent simple salts of certain le salts. Thus assuming, for sake of simplicity, all double salts are of the form $\rightleftharpoons$, Alcohol double salt $\frac{C_4H_5\uparrow O}{H\downarrow O}$ analogous to $\frac{K\uparrow O}{H\downarrow O}$. By ment with $H:O;S,O_3$ in a closed vessel, acng to Graham's process,* this change ensues,—

$$\frac{C_4H_5\uparrow O}{H\downarrow O}+H:O;S,O_3=\frac{H\uparrow O;SO_3}{H\downarrow O}+C_4H_5:O,$$

uble salt of oil of vitriol and water being ed, and Ether being liberated as a single salt.

Sulphovinic Acid.

56. The process by distillation, in which "Sulic Acid" (probably the double Sulfite of yl and Hydrogen) occurs as an intermediate e of the transformation, may be represented :—

$$\frac{H_5\uparrow O}{H\downarrow O}+(H:O;S,O_3)_2=\frac{C_4H_5\uparrow O;S,O_3}{H\downarrow O;S,O_3}+2(H:O)$$

$$(H:O;S,O_3)+H:O+C_4H_5:O.$$

Williamson's method is explained with evident ciency after this fashion :—

$$\frac{K\uparrow O}{C_4H_5\downarrow O}+C_4H_5:I=K:I+2(C_4H_5:O).$$

Williamson's Ethers may be double salts.

57. It is obvious that the double-salt theory, supported, is equally applicable to the whole s of remarkable compound Ethers produced Mr. Williamson. We may hold that they are, and all, double salts, being Alcohols in which

* Qu. Journ. Chem. Soc., vol. iii. p. 24.

the Hydrogen of the coupled water is replaced by, or has conjugated to it, a hydrocarbon molecule.

alysis n Ethate ed.

258. A few more experiments however are required to clear up a doubtful point or two in connection with the compounds which we have just been discussing. One of these is the voltalysis of the double oxide of Potassium and Ethyle, or Ethate of Potassium, as it may be called,* $\frac{K\,|\,O}{C_4H_5\,|\,O}$. A more instructive experiment could scarcely be made: one or other of its results would be remarkable, as respects Mr. Williamson's notions of its constitution. For, of the only two positive results which it could yield, the one would confute one of his theories, the other another. Either the Ethyle will come off at the cathode, with the Potassium, or it will escape at the anode. In the former case Alcohol cannot be a peculiar acid in the same sense as Acetic Acid is, which evolves its hydrocarbon among the constituents of its style. In the latter case a molecule of Potassium-Alcohol cannot be formed by the substitution of Ethyle for one half of the Hydrogen of water and of Potassium for the other half, for the whole Hydrogen of water comes off under voltalysis on the same side of the com-

* This name "Ethate" is allowable provisionally, so long as we bear in mind that it does not imply that the Ethyle is by special property always antibasic, but only that in a double salt in which the other base is very powerful, it may perhaps play the part of an antibase, as seems to be the case sometimes with the Hydrogen of water.

ad.* The second alternative result would prove the Alcohol was not formed by the substitu- of half the Hydrogen of a single molecule of er, but, by the coalition of at least two such ms, in one of which the whole Hydrogen was er replaced by Ethyle or had conjugated to it molecule $(C_2H_2)_2$. Under the first alternative unitary theory would still be tenable as applied this compound, though still utterly inapplicable numberless cases which it claims to interpret, d still devoid of proof for those cases in which is not disproved.

259. Another experiment which we require is, the construction of the Iodides [Iodedes] corresponding to Williamson's compound Oxy-ethers, and the subjection of the Sodium- or Potassium-Alcohols to the action of these Iodides. It is reasonable to suppose that, if these compound bodies be analogous to Ether in constitution, they will, like it, admit of the substitution of some of the other Halogens for their Oxygen by double decomposition. In this case the two basic members of the

Experiments on the Iodides of these bodies needed.

* Of course we can imagine the Hydrogen of water to be replaced by another body, so as to produce a new compound, which shall so far differ from the prototype as not to be at all a voltalyte; or the whole of the water, and, by parity of reasoning, the whole of any of its derivative antitypes, may be received possibly at the anode, with the other constituents of a style. But we cannot, I think, conceive that the type shall be so destroyed, that one part of the antitype of the Hydrogen shall usurp the place of the whole, by becoming the entire positive member, while the other half passes over to a subordinate position on the negative side.

compound Ether would either separate from their coupled state, each with its equivalent of Iodine, or they would remain together, with the addition of the two atoms of Iodine, as a compound, which, even by the unitarians, must be called a double salt. Thus, supposing that Hydriodic Acid [Iodic Acid] could be induced to effect an interchange of Halogen with the double oxide of Ethyle and Methyle, we should have $\left.\begin{matrix}C_2H_5'\\C\ H_3'\end{matrix}\right\}O+2(H'I')$ either=

$C_2H_5'I'+CH_3'I'+H_2'O$, or $=\dfrac{C_2H_5'\,|\,I'}{C\ H_3'\,|\,I'}+H_2'O$; or,

in the usual symbols, as I suppose—

$$\frac{C_4H_5\,|\,O}{C_2H_3\,|\,O}+2\,HI \text{ either} = C_4H_5{:}I+C_2H_3{:}I+2(H{:}O)$$

$$\text{or} = \frac{C_4H_5\,|\,I}{C_2H_3\,|\,I}+2\,(H{:}O).$$

If we obtain the former result, it will, I think, confirm very strongly the notion that the double Oxy-ether was a double salt, whose components have been sundered during the interchange of Halogen. If we obtain a double Iodine-Ether, we are now in a condition to try whether this body will effect a double decomposition with, for instance, the Sodium-Amyl-Alcohol [Sodi-Amate?].*

Quadruple salts may so be formed.

260. If this experiment succeeds, we shall now have Ethers of a higher degree of multiplicity, quadruple at least, which will, I think, effectually neutralize any support which the duplicity of the first set of new Ethers may have seemed to give

* See note to § 258, p. 252.

theory of the duad condition of the Hy-
of water. We should, I suppose, have
according to the unitary scheme,—

$$\left.\begin{matrix} I_{11}' \\ Na' \end{matrix}\right\} O) + \frac{C_2H_5' \mid I'}{C\,H_3' \mid I'} = 2(Na'I') + \left.\begin{matrix} C_5H_{11}' \\ C_2H_5' \\ C\,H_3' \\ C_5H_{11}' \end{matrix}\right\} O_2;$$

ording to the ordinary theory,—

$$\frac{C_{10}H_{11} \mid O}{Na \mid O}) + \frac{C_4H_5 \mid I}{C_2H_3 \mid I} = 2(Na:I) + \frac{\begin{matrix} C_{10}H_{11} \mid O \\ C_4\,H_5 \mid O \\ C_2\,H_3 \mid O \\ C_{10}H_{11} \mid O \end{matrix}}{}.$$

sulting Ether, in this case (supposing the
ange to be complete, and to be effected ac-
to the exact analogy of the simpler muta-
scovered by Williamson), will be, according
usual symbols, a quadruple salt, resulting
he coalescence of two molecules of double
How such a compound would be described
unitarians I am not aware. Nor am I suffi-
skilled in the use of their symbols to be
at I have represented the possible reaction
simplest form in which these are capable
ing it. But I have endeavoured to do so.

If the unitarians could show that in all cases of dibasic oxides [oxedes] the corre-
ng double iodides [iodedes], chlorides [chlo-
, etc., could not be formed, they would have
for their theory, as applied to the truly saline
unds, a negative support stronger than any
e ground that has yet been adduced for it
on.

The opposite results would support the unitary views.

Section III.

Of the Thyloids.

"Thyloids," *e. g.* Fenyle.

262. Besides the Thyles proper, there are two or three other complex bases of the group of Hypobases which by certain points of analogy in their composition and in their behaviour claim to be considered as closely allied to the Thyles; such therefore we may call Thyloids. Of these, the one which most nearly approaches in function to the bases which we have been considering is Fenyl, $C_{12}H_5$=Fn. It is probable that this molecule is one of a series of bases of the form $C_{2n}H_{2n-7}$, which are analogous to, but less decidedly basic than, the series of the Thyles; but at present we do not know any of this series in the substantive state, and until very lately we have scarcely been certain of the existence of any of them, except Fenyl, in a basic position, and we have hitherto no grounds for expecting that this one can be isolated. We however know several compounds in which $C_{12}H_5$, $C_{14}H_7$ and others of the series are present in a condition that renders their potential basicity highly probable.* Until lately, perhaps, we were not certain that even Fenyl holds the position of a true base in any simple single salt, as Ethyle does in its oxide, sulfide, iodide, etc. However, it was supposed possible that "Benzonitrile" ($C_{12}H_5$,C_2N) might be the cyanide [cyade] of Fenyl, and Hofmann's "Ani-

* See note to P. III. Ch. V. sect. 6, div. ii.

" was taken to be in all probability
cyate] of this base, $C_{12}H_5:O;C_2N,O$.
true constitution of the latter com-
this is indicated very clearly by its re-
$_2H_5$ is here distinctly basic. Again, in
ccording to Chancel,† "Benzofenone,"
H_5,O [Benzate of Fenyl?], Fenyl may
ıt recently the discovery by William-
ıgham‡ of the Chloride [Chlorade]
'hosfate [Phosfute] $(C_{12}H_5:O)_3;P,O_5$,
lts of Fenyl obtained by means of
Pentachloride of Phosphorus [Chlo-
"hydrated oxide of Fenyl" has esta-
sicity of the Fenyl molecule. Perhaps
an antibase in Carbolic [Fenaric?]
body be H:O;Fn,O. If, however, as
, this body be analogous to Alcohol,
a double salt, and will have to be
$\left.\begin{matrix}H\\Fn\end{matrix}\right\}O$, in conformity with its synonym
ide of Fenyl" [Fenyl-Hydrate]. And
ect, our Fenyl is here placed as a true
ct that the compound just mentioned
)ine with aqueous H_3N, that is to say,
the complex salt $H_3N;H:O;C_{12}H_5O$,
rong evidence that it is not a true
t its Potassium compound, like the

Chem. Soc., vol. ii. p. 315.
ndus, t. xxviii. p. 83.
March 25, 1854, p. 397. Proceedings of Royal
8. Qu. Journ. Chem. Soc., vol. vii. p. 238.

Potassium-Ethyl-Alcohol, is really a double salt, $\frac{Fn\uparrow O}{K\downarrow O}$, such that we may properly call it Fenyl-Alcohol. We know that Fenyl becomes decidedly antibasic by the substitution of NO_4 [Nitrome or Nome] for a considerable portion of its H.; for from $\frac{C_{12}H_5\uparrow O}{H\downarrow O}$ we thus obtain $H:O;C_{12}\left\{\begin{matrix}H_2\\(NO_4)_3\end{matrix}\right\},O$, Carbazotic [Trinomifenaric] Acid, of which the true acidity is indubitable. It is possible that, in the double oxide of Potassium and Fenyl, the strong basic energy of the Potassium may have induced on the Fenyl the same effect, which in this acid results from the introduction of the oxygenous molecule into its substance, namely, the placing it in the antibasic position; but it would not follow from this that it was antibasic in the original "hydrated" compound. We have rather, from the behaviour of Fenyl with this very NO_4, reason for inferring its basicity; for when only one equivalent of H. is substituted in it by this oxygenous molecule, it still fills, in Nitraniline, $C_{12}\left\{\begin{matrix}H_4\\(N,O_4)\\H_2\end{matrix}\right\},N$, a place which is usually occupied by a basic group.* Gerhardt, in his admirable digest of "organic" chemistry,† arranges with the Fenyl compounds a body which has been called Pyrocatechine, having the composition $C_{12}H_6O_4$. To this body, Gerhardt, call-

* See P. III. Ch. V. sect. 6, div. ii.

† Traité de Chim. Org., t. iii. p. 62.

it Oxyphenic Acid, provisionally assigns a constitution, which we must represent as $H:O;C_{12}H_5,O_8$ [Fenic Acid?]. Here Fenyl is supposed to be antibasic, but without sufficient grounds. For in the first place no connection between this body and the Fenyl group is indicated by its mode of formation, or by anything that is yet known of its habits: and again, it is extremely doubtful that it is an acid or hydrostyle at all. Its reactions by no means indicate hydrostylic function. It is at least as likely that this substance is a true homologue of Furfurol $\left(\frac{H}{C_{10}H_3O_2}\middle|\frac{O}{O}?\right)$,* and that it is of alcoholic form, having the molecule $C_{12}H_5O_2$ as a hypobase; thus, $\frac{H}{C_{12}H_5O_2}\middle|\frac{O}{O}$. We shall hereafter† meet with a probably basic molecule of this Fenyl-oxygenous composition. This body may however be of aldehydic form, thus, $H:O;C_{12}H_5O_2,O$, with $C_{12}H_5O_2$ antibasic.

263. The question, it will be borne in mind, which is sometimes put concerning a body or molecule of doubtful function,—whether it be or be not a "radical"?—is a very vague one. In such cases, generally, and in our present instance specially, the first question should be, "Is it a base or antibase?" Then, if it be a base, a second inquiry arises: "Is it a normal and decided base, or does it, like some of the aberrant metallic bases, sometimes

Fenyl may act as an antibase.

* See note to P. III. Ch. V. sect. 6, div. iii.

† See P. III. Ch. V. sect. 6, div. ii.

act as an anhydride?" The latter may perhaps be the case with Fenyl. In the case of "Carbolic Acid," as of so many other so-called acids, the nitric analysis is the only certain mode of ascertaining on which side of the system the hydrogen-bearing group is placed. Positive evidence of basicity may be afforded by the substitution of a basic metal for the doubtful molecule; but the failure of such substitution cannot be taken contrariwise as proof of antibasicity. Again, the mere substitution of a basic metal for one atom of Hydrogen in an compound is no proof of the acidity of the latter or of the antibasicity of its doubtful member; for this substitution may be equally effected if the compound be a double salt having water for one of its members.

The basicity of Fenyle.

264. The existence of Benzole ($C_{12}H_6$) containing, apparently, Fenyl united with Hydrogen, cannot be taken as any indication that Fn. is not a base. For the discovery by Mr. Frankland,* of bodies containing just one equivalent of Hydrogen more than do the Ethyloid bases, has shown us that, though we might not have expected it, the union of two molecules which act as bases may produce a body perfectly inert as respects the stylobasic attachment.† We may therefore take Benzole

* *Qu. Journ. Chem. Soc.*, vol. ii. pp. 290, 298; vol. iii. p. 59.

† It has recently (Notices of Meetings of Royal Institution, vol. i. p. 451, June 2, 1854) been argued by this same chemist that molecules of similar chemical character generate by their union compounds of similar energies, but of higher intensity. This is undoubtedly true in certain cases, which Frankland ex-

$C_{12}H_5, H$) as affording another indication of the analogy between Fn. and the true Thyles. It had been stated some time ago by Kolbe* that the substance called Creosote, which is found in the tar produced by the destructive distillation of certain non-resinous woods and of coal, is a compound homologous with the Fenyl-hydrate which occurs abundantly in coal-tar. Deville† had assigned to Creosote a composition ($C_{14}H_8O_2$) confirmatory of

strictly cites in support of this view, as respects basic or volta-positive molecules, as we shall presently observe. Such neutral compounds however as his "hydrurets" of the Thyles do not countenance it as a general rule. It is certainly not true as applied to stylic molecules; for no single instance is known of the formation of a stylic compound by the coalescence of two or more molecules themselves stylic. Numerous epistyles are formed by the union of stylic atoms; but this is a result altogether different from the generation of styles or volta-negative bodies, being parallel to the production, not of bases, but of epibases. Frankland uses the terms "acid" and "electro-negative body" as equivalent expressions,—hence the fallacy. Obscurity is inevitable under an unorganized state of a scientific terminology. It is this obscurity which now permits laxity of thought to the writer, and often entails confusion upon the reader, of chemical essays. See § 270, p. 278.

* Qu. Journ. Chem. Soc., vol. iv. p. 70 (1851). Kolbe here maintained that Creosote is homologous with Fenyl-Alcohol, and that Anisole, with which Creosote is isomeric, is not homologous thereto. I conceive that if Creosote has the constitution $\frac{C_{12}H_5\uparrow O}{H\cdot O}$, which represents his view, both it and Anisole, $\frac{C_{12}H_5\uparrow O}{C_2H_3\cdot O}$, are true homologues of $\frac{C_{12}H_5\uparrow O}{H\cdot O}$. Creosote differs from the latter body by C_2H_2 added to one of its basic molecules, like Fn.; while Anisole has the same increment added to the other, namely, to the H.

† Annales de Ch. et de Phys. ser. 3, t. xii. p. 228.

this view, according to which this compound co
tains $C_{14}H_7$ in the same position in which C_{1}
lies in the Fenyl-hydrate. This has recently be
established by the experiments of Mr. Scrugha
who has shown that Creosote contains a molecu
$C_{14}H_7$, to which he assigns the name "Cresyl," a
which, notwithstanding unitarian formulæ, I mu
state to be evidently basic in its Alcohol Creoso
and in certain other compounds which this chemi
derived therefrom. But there can be little dou
that we have the means of producing any day se
ral members of the series $\frac{C_{2n}H_{2n-7}\uparrow O}{H\ \downarrow O}$. Hofma
has shown,* in confirmation of a statement p
viously made by Mr. T. S. Hunt,† that "Anilin
($C_{12}H_7,N$), when treated with Nitrous Acid [N
trire] (NO_3) yields its costirpial Fenyl-hydra
Now by similar reactions, "Toluidine" ($C_{14}H_9,N$
"Xylidine" ($C_{16}H_{11},N$), and the other compou
homologous with Aniline and analogous to A
monine, ought to yield bodies homologous w
$\frac{C_{12}H_5\uparrow O}{H\ \downarrow O}$ and costirpial with themselves resp
tively, namely, $\frac{C_{14}H_7\uparrow O}{H\ \downarrow O}$, $\frac{C_{16}H_9\uparrow O}{H\ \downarrow O}$, etc. It
somewhat curious that these highly interesti
members of a favourite family have not yet be
produced by this beautiful transformation. If T
uidine should thus be found to generate Creosote
would certainly be a very satisfactory result.

* Qu. Journ. Chem. Soc., vol. iii. p. 231.

† Silliman's American Journ. 1849, Nov.

ecently informed by Cannizzaro* that
l ,, having the composition $C_{14}H_8O_2$ is
y the action of an alcoholic solution of
a oil of bitter almonds [$H:O;C_{14}H_5,O$,
azate]. If this oil be an Alcohol, its for-
be $\frac{C_{14}H_7\uparrow O}{H\downarrow O}$, having the molecule $C_{14}H_7$
d it may compete with Creosote for the
eeding the Fenylic Alcohol in its own
The chloride $C_{14}H_7:Cl$, and the acetate
$C_{14}H_7:O;C_4H_3,O_3$, are described by the
hor, so that there is little doubt of the ba-
the molecule $C_{14}H_7$. It is, however, not
that the carbonous base of this Alcohol is
true coserial of Fenyl; it may belong to
series of homologous bases, isomeric with
f the Fenyl series. This new Alcohol is at
y temperatures liquid, while Fenylic Alco-
rystalline. The key to this difference may
he double series of isomeric compounds, of
Aniline and Picoline are respectively mem-
both of these bodies have the composition
N, and both probably contain a molecule
.†

. At present however it may be said that the y of all the other Thyloids of the series $_{n-7}$, though probable, yet requires demonn by the actual production of their salts. As ir constitution, we have only the speculation,

The Thyloids not proved yet to be basic.

* Qu. Journ. Chem. Soc., vol. vii. p. 192.

† See P. III. Ch. V. sect. 6, div. ii.

which is suggested by the uneven number of t
equivalents of Hydrogen, that they, like the
Thyles, are formed by the annexation to
Hydrogen of Hydrocarbon molecules contai
even numbers of atoms of Carbon and of
drogen. For these Fenyloid bases such adju
would be of the form $C_{2n}H_{2n-8}$. And sinc
here have again a series of systems rising one a
the other by the addition of C_2H_2, we may
pose that these adjuncts are formed upon a
cleus, at which we shall arrive by successive de
tions of C_2H_2 from any given term of the
We may put $C_{2n}+H_{2n-8}$ into the equivalent
$C_8+(C_2H_2)_n$. Thus we may conceive the pri
or nuclear adjunct to be C_8, and that the first
pound of the Oxyhydrate or Alcohol series i
family, for instance, would be $\frac{H\uparrow O}{C_8,H\downarrow O}$, the s
being $\frac{H\uparrow O}{C_2H_2.C_8,H\downarrow O}$, and the third, the lowe
known, $\frac{H\uparrow O}{(C_2H_2)_2.C_8,H\downarrow O}=\frac{H\uparrow O}{C_{12}H_5.O}$. It is
sible that the two lowest members of this
may be obtainable by treating "Seminafthali
($C_{10}H_5N$) and "Sinnamine"* ($C_8H_6N_2$) r
tively with N,O_3. The Pyridine of Ande
which is isomeric with Seminafthalidine, see
belong to another series of bodies just now al

* But not likely in the latter case. See note to P. III.
sect. 6, div. vi.

† Qu. Journ. Chem. Soc., vol. v. p. 53.

h contain molecules having the same com-
, but not identical, with the Fenyloids.*
however we have this hypobasic Fenyloid
e $C_{10}H_3$ in the so-called "chloride of Naftha-
hich is commonly represented as $C_{20}H_8,Cl_4$.
lecule of Nafthaline $C_{20}H_8$ has the compo-
f the unknown hydrocarbon which would lie
low Benzole ($C_{12}H_6$) in the same series, in
Toluole ($C_{14}H_8$) lies above it. The molecule
required hydrocarbon ($C_{10}H_4$) seems to be
ed in Nafthaline. The occurrence of Naf-
with Benzole, Toluole, etc., in Coal Tar, in-
that Nafthaline may probably owe its origin
oubling of another of this family. Now this
ic group of atoms is actually split in several
s, as in the formation of Nafthalic Acid
$_8H_2,O_3$) by the action of NO_5 on "Sub-
of Nafthaline," $C_{20}H_8Cl_2\left[\frac{H}{C_{20}H_7}\middle|\frac{Cl}{Cl}\,?\right]$,† that of "Seminafthalidine" $C_{10}H_5N$, from naftese," $C_{20}\left\{\begin{matrix}H_6\\(NO_4)_2\end{matrix}\right\}$. It is not unlikely is also subdivided by the further action of $_{20}H_8Cl_2$, and that the compound resulting is action may be, not $C_{20}H_8,Cl_4$, but with a equivalent weight, $\frac{C_{10}H_3}{H}\middle|\frac{Cl}{Cl}$: if so, we have

264, p. 263. Qu. Journ. Chem. Soc., vol. vii. p. 107.
t $C_{20}H_7$ basic? It seems that we have it in a position
ken by bases in Nafthalidine $\left.\begin{matrix}C_{20}H_7\\H_2\end{matrix}\right\}N$.

here an exact analogue of $\frac{C_{12}H_5}{H}\}O$. The last n
lecule, $C_{10}H_8$, perhaps also occurs in Furfur
It is not unlikely that the hydrocarbon C_{1}
hemimeric with Nafthaline, $C_{20}H_8$, and homo
ous with Benzole $C_{12}H_6$, may yet be found in
Tar. If so, we should obtain from it in
forms of combination the fenyloid molecule C
Mr. C. G. Williams* looked there for it, and
ing to secure it, intended to try again. I
distilled a considerable quantity of crude Coal
Benzole, in the hope of finding this hydroc
among the most volatile products boiling
70° C. Of these I have kept all I could obta
every occasion for the purpose of a full exa
tion, for which I have never had opportunity.
superficial experiments, which I have made o
different samples of the scarce oils that com
before Benzole, have always indicated that
chief ingredient is a highly volatile liquid w
peculiar alliaceous smell, and containing Sulf

Thyloid nature of Allyl and of Lipyl.

266. The molecule C_6H_5, Allyl, which occ
Garlic Oil, C_6H_5:S, a sa Sulfide [Sulfade]
in Mustard Oil, C_6H_5:S;C_2N,S, as a Sulfocy
[Sulfocyate], must also be reckoned amon
thyloids. Containing C_2 more than the basi
lecule Ethyl, C_4H_5, being, in fact, isomeric
Propyl, C_6H_5, the antibase of Propionic [Pro
Acid, Allyl cannot be expected to exhibit
marked basic properties. Indeed but few

* Qu. Journ. Chem. Soc., vol. vii. p. 107.

compounds are known, and of them the basistylic character is rather to be inferred as probable, than asserted as proven. A new reason for supposing Allyl to be truly basic will be pointed out in a future page. Allyl makes no pretensions to have been isolated. Under the head of Hypobases we must also include the basic molecule which is found in certain fat-oils, combined with the stylic members of some of the elæogenous acids; this is Lipyl, C_3H_2. None of the simple compounds of this base with any of the halogens are known, unless "Acroleine," commonly considered as $C_6H_4O_2$, be, as perhaps it is, $C_3H_2{:}O$.* The oxide, however, when separated from the fatty salts, immediately com-

* The fact that Acroleine is formed by the simple dehydration of Glycerine would indicate that the constitution of the former is $C_3H_2{:}O$. It may however be $\frac{C_3H_2 \mid O}{C_3H_2 \mid O}$, or $H{:}O;C_6H_3,O$. The latter formula must be assigned to it, if it be, as Berzelius supposed, an analogue of Aldehyde. It is not impossible that both the isomeric forms $C_3H_2{:}O$ and $H{:}O;C_6H_3,O$ exist, since Acroleine seems to be transformed spontaneously into another isomeric substance when kept in close vessels with exclusion of air. To the one of these forms of matter one formula may be appropriate, to the second the other. At any rate, the generation of Acrylic (Acriric) acid, $H{:}O;C_6H_3,O_3$, by the oxidation of Acroleine, cannot be taken as evidence that the simpler formula does not belong to the latter body. The change is a very interesting one, showing that the molecule of Lipyl, in passing from the basic position to the antibasic, becomes dimerized, and then loses one atom of H., which remains basic to the system;—the antibase Acryl, C_6H_3, containing more C. in proportion to its H. than does its basic relative. Whether this process takes place previously to, or simultaneously with, the oxidation, is the

bines with water, forming the compound "Glycerine," which is, probably, a multiple salt. The exact nature of Glycerine had long been involved in some obscurity,—the inertness of its special base, Lipyl, having enabled it to escape the usual double decompositions to which saline systems are liable. The formation of the Butyrate [Butite] of Lipyl ($C_3H_2:O;C_8H_7,O_3$) by Pelouze and Gélis, was the only instance in which such a combination had been effected. However, the recent application by Berthelot* of the method of high temperature and pressure, which has of late so much extended the range of our reactions, has thrown a new light upon Glycerine. By subjecting this body to such treatment in contact with several elæogenous and other zoogenic hydrostyles, this chemist has succeeded in forming salts containing Lipyl combined with the stylic members of these latter bodies. Among the compounds thus formed are some which are identical with the natural fats from which Glycerine is obtained. He has also formed, by the action of Hydrochloric [Chloric] Acid on Glycerine, a compound which probably contains the Chloride

point to be determined. This connection is analogous to that which we find between certain other bases, and certain antibases which are cognate with them (see § 267, p. 272), though the increment of C_2, which characterizes these relations, is different from that (C_3H) which occurs in the present instance. If $H:O;C_6H_3,O$ be the formula of Acrolcine in either of its isomeric conditions, it should, when in such state, be called Acraric acid, or Hydr-acrate in our nomenclature.

* Qu. Journ. Ch. Soc., vol. vi. p. 280. Compt. Rend. t. 37, p. 398.

[Chlorade] of Lipyl, as one of the members of a multiple salt.

Artificially formed salts of Glycerine.

267. The compounds discovered by Berthelot seem to be salts of different degrees of multiplicity. Of each of these the following are respectively instances. I give a polar configuration to his formulæ, to represent what I suppose to be the constitution of the bodies. The names are those of Berthelot.

Monopalmitin," $\dfrac{\begin{array}{l|l} C_3H_2 \uparrow & O; C_{32}H_{31}, O_3 \\ \hline C_3H_2 & O \end{array}}{(H \downarrow O)_3}$, a quintuple salt.

Butyridin," $\dfrac{\begin{array}{l|l} C_3H_2 \uparrow & O; C_8H_7, O_3 \\ \hline C_3H_2 & O \end{array}}{(H \downarrow O)_2}$, a quadruple salt.

Dipalmitin," $\dfrac{C_3H_2 \uparrow O; C_{32}H_{31}, O_3}{(H \downarrow O)_2}$, a triple salt.

Tetrapalmitin," $\dfrac{C_3H_2 \uparrow O; C_{32}H_{31}, O_3}{H \downarrow O; C_{32}H_{31}, O_3}$, a double salt.

Berthelot describes other similar compounds, in each of which one or other of the antibasic molecules C_4H_3 [Acetyl], $C_{10}H_9$ [Valyl], $C_{34}H_{33}$ [Margyl], and $C_{36}H_{35}$ [Steyl], are substituted for the C_8H_7 [Butyl] and the $C_{32}H_{31}$ [Palmyl] of the bodies here instanced. I have halved the equivalent numbers assigned by Berthelot to the two latter of the above examples. If the more complex formulæ are adopted, which I conceive is unnecessary, these would become respectively sextuple and quadruple salts. The chlorine compound obtained by Ber-

thelot, which he calls "Chlorhydrin," is probably $\frac{C_3H_2\uparrow Cl}{C_3H_2|O}{(H|O)_3}$, a quintuple salt. According to this view, Glycerine is $\frac{(C_3H_2\uparrow O)_2}{(H|O)_4}$, or more probably, $\frac{C_3H_2\uparrow O}{(H|O)_2}$. Lipyl appears to have a strong tendency to confer upon the compounds, into which it enters, the habit of duplication or of forming double salts. It appears to act as a base in connection with certain acids, which themselves affect a multiple form in their combinations. Thus are formed certain so-called "coupled acids," which have, I conceive, rather a complicated structure. Thus we have

"Glycerisulfuric Acid," $\left\{\begin{matrix}\frac{H\uparrow O;S,O_3}{C_3H_2|O;S\ O_3}\\ C_3H_2|O\end{matrix}\right\}{(H|O)_3}$.

This compound seems to be a sextuple salt, in which the single atom of H., which is basic to one of the molecules, $O;SO_3$, is replaceable by other bases. The brackets indicate the twofold doubling due respectively to the molecules $O;SO_3$ and C_3H_2. Somewhat similar are the "Glyceriphosfates."

$$\left\{\begin{matrix}\frac{B\uparrow O}{B|O}\\ \frac{C_3H_2|O}{C_3H_2|O}\end{matrix}\right\}{(H|O)_3}\ P,O_5$$

Here B. represents a molecule of replaceable base.

The peculiar *inertia* of the Lipyl seems to enable it to resist expulsion by the less powerful bases. There are no indications of the base C_3H_2 or of any other peculiar molecule, which may be supposed to be basic in these compounds, being isolable as a free body. At present Lipyl seems to stand alone as a single species of its own genus; perhaps we shall yet discover other molecules having similar claims to the position of a base or hypobase. There are other carbonous molecules which do not differ very widely from some of these thyloids in composition, and which, being known in combination with certain halogens, chiefly with Cl., seem to be considered by some chemists to be of a basic nature. At least, I suppose, the term "radical," if applied to a body which is decidedly not stylic, and which is not distinguished by any term corresponding to the word antibasic, must be taken to mean a base, especially when the saline form of nomenclature is given to the names of its compounds with the halogens, "Chloride," "Bromide," etc. It has not been shown that the compounds to which I allude are salts, or that they contain any bases at all. There are strong reasons for believing that they are not salts, but that they belong to a different type. We have not any right therefore to consider the molecules, which in them are combined with halogens, as being bases; so that they cannot belong to our group of thyloids. The following are instances of the compounds in question:—

C,OCl, "Phosgene gas" [Unichlorcarbeme]
C_4H_3,Cl, "Chloride of acetyl" [Chloracetame?]
C_4H_3,O_2,Cl, "Chloride of othyl"* [Unichloracetime]
$C_{14}H_5,O_2Cl$, "Chloride of benzoyl" [Unichlobenzime].

These compounds are epistyloid parahales, being, with the exception of the second, examples of compounds formed from epistyles, by the substitution of Cl. for one atom of metastylic oxygen. The formation by Gerhardt† of double compounds, each containing the epistyles of two zoogenic acids, may be considered at first sight as indicating the basicity of some of the molecules that, in such compounds, are united with halogens. Thus the compound, which Gerhardt calls "Acetic Benzoate," or "Benzoic Acetate," and which he represents as $\left.\begin{matrix}C_2H'_3O\\C_7H'_5O\end{matrix}\right\}O$, and which in the usual notation becomes $\frac{C_4H_3O_3}{C_{14}H_5O_3}$, may be supposed to contain an oxybase, the oxide of a basic molecule, united with an epistyle. But which of the two members of this body, the Acetic, or the Benzoic, contains the base? Shall the system be considered as $C_4H_3O_2{:}O;C_{14}H_5,O_3$, or as $C_{14}H_5O_2{:}O;C_4H_3,O_3$? There is no evidence in favour of either formula, nor have we any reason

* The term "Othyl" has been proposed by Williamson to express the molecule which he supposes to be formed by the replacement of a part of the H. of Ethyl by O. This is represented by him as $C_2H'_3O$: it corresponds to the $C_4H_3O_2$ of the ordinary notation. Qu. Journ. Chem. Soc., vol. iv. p. 352.

† Qu. Journ. Chem. Soc., vol. v. pp. 127, 226; vol. vi. p. 184. L'Institut, July 20, 1853, p. 242.

CHAPTER III.

OF THE SYNTHYLES.

Synthyles and their varieties. Metallothyles.

268. In connection with the Thyles and other Hypobases, we may very appropriately consider several remarkable Bases which have been produced, chiefly within the last few years, from certain of the Thyles proper, by combining them with additional molecules of certain elementary bodies. These may be called generally the "Synthyles" (*σὺν, in combination*). In the greater number of these species, the elements to which the Thyles are thus conjugated are metals. We may call such compounds "Metallothyles." Of these, the Kakodyl of Bunsen (C_4H_6,As) was the first that was made known to us. Bunsen showed that the Oxide [Oxade] of this base occurred among the substances obtained by distilling Acetate [Acetite] of Potassium with Arsenious Acid [Arsenire]. He afterwards succeeded, not only in preparing other salts containing this basic molecule combined with various styles, but ating the base itself. This Kakodyl, being

the first compound base that had been obtained, justly engaged the attention of chemists in an eminent degree. Though later discoveries have deprived this body of its singularity, by presenting us with others more or less analogous to it in composition and in behaviour, they have by no means lessened the interest which belongs to it, as the type of a group of compounds which resemble the elementary metallic bases in their chemical behaviour.

Kakodyl and analogous Metallothyles.

269. The Salts of Kakodyl have the composition $C_4H_6,As:St$. Its basicity, though decided, is not of a very high degree of energy. This is to be inferred from the fact that its Oxide is not a strong Oxybase, not combining with the weaker epistyles. In this respect it approaches somewhat towards the simpler Thyles among the Hypobases. We find this feebleness as a base connected with a marked antibasic tendency in Kakodyl. The oxide $C_4H_6As:O$ readily absorbs Oxygen, and becomes "Kakodylic Acid," C_4H_6As,O_3 [Kakodire], which is not an acid, but an epistyle.* It has been shown by Kolbe† that Kakodyl probably consists of two molecules of Methyl, (C_2H_3), united with one of Arsenic, $(C_2H_3)_2As$. We do not know in what manner these constituent molecules are severally related to each other and to the properties of the base itself. It has been supposed that the basic quality of the entire compound is due to one of the particles of

* See § 127, p. 105.

† Qu. Journ. Chem. Soc., vol. iv. p. 48.

Methyl, so that its salts might be represented thus:—Me,As;Me:St. It will be observed that this formula for the Kakodylistyles is precisely analogous, or rather antilogous, to that of the Cyanoferrates B:Cy;Fe,Cy, the As. corresponding to the Fe., and the basic Me. to the stylic Cy., but on the other side of the structure. But there is this great difference between the two systems, that the complex base of the former is isolable; the complex style of the latter is not. And again, the formula thus suggested for the Kakodylistyles is not likely to be the true one, because, as will be hereafter seen, though we have numerous bases constructed upon a form nearly resembling this, we know not one instance in which a true Base,—containing a central nonbasic molecule like As., with other basic molecules, whereof one is more properly basic than the rest,—can be isolated. Again, in all such cases the accessory member not only can be separated, but always separates of itself, from the proper basic molecule, when the style of such complex salt is directly disunited from its sympole. But we have no signs of any such compound as C_2H_3,As, which we should expect, from the analogy of other bases, if C_2H_3,As were here an adjunct to basic C_2H_3.*

* Another "radical," Kakoplatyle, supposed to have the composition $C_4H_7AsPtO_2$, is commonly described in connection with Kakodyle. "This radical, whose basic character is quite obvious" (Gregory's Handbook of Org. Chem. ed. 3. p. 182), is unknown in the separate state. The compounds, which are imagined to contain this complex base, are probably treble salts, having the three bases C_4H_6,As=Kd., Pt., and H. Thus, I suppose, the

e considerations are equally opposed to Lau-
's view,* that Kakodyl contains a molecule
$_5$,As, analogous to Aniline, $C_{12}H_7N$. If this
the case, the salts of this base would be of
form C_4H_5,As;H:St, and we should expect,
o succeed as we do in isolating C_4H_6As, but
tain C_4H_5,As, which we cannot. We require
er experiments for the determination of the
itution of Kakodyl, and of the position which
metal Arsenic occupies therein. We may be
ied, however, that the basicity of the system
nds more directly upon the hydrocarbon mo-
es than on the Arsenic; and we may consider
ost likely that its antibasic tendency results
y from the influence of the antibasic metal.
in order of natural affinity, but not of chro-
y, we now have a compound precisely analo-
in composition to Kakodyl, but resulting from
y different process. This is the Ethyl-Kakodyl
obtained, together with another allied com-
d, which we shall have to notice hereafter,

is $\begin{matrix}Kd\uparrow O\\ Pt\ |\ O\\ H\downarrow O\end{matrix}$, the Choride $=\begin{matrix}Kd\uparrow Cl\\ Pt\ |\ O\\ H\downarrow O\end{matrix}$, the Sulfate [Sulfite] =
$;SO_2$
. We shall have occasion to note hereafter, that in

multiple salts containing Platinum, we sometimes find only
olecule of style, readily replaceable, or one so much more
than the others, as to give to them an appearance of absolute
nce to the base-member.
Comptes Rendus, t. 31, p. 349.

* Zeitschr. für prakt. Chem., b. lx. s. 286 (1853).

† Ann. Chem. Pharm., vol. ii. p. 257; vol. vi. p. 57.

‡ See also Calvert and Richardson on these compounds. Compt. Rend. t. 36, p. 95, and t. 36, p. 1001. Annalen der Chem. und Pharm. bd. lxxxiv. s. 229, and Löwig, ibid., b. lxxxiv. s. 308. Also s. 318, s. 326.

bases which contain Zinc are very unstable, g easily decomposed by the action of water; -Methyl even takes fire in the air, and is de- red with the formation of the Oxides of its ele- ts. Those which contain Tin appear to imitate weak antibasic tendencies of that metal in the binations which their Oxides form with Po- . However, these bases are all readily isolable; combine directly with the Halogens, forming salts of the composition Thy,Mb:St; and among e the Oxides [Oxades] seem to indicate, by solubility in acids, that they assume the oxy- us epistyles to form salts with complex styles. heir vigilant attachments these bodies differ arkably from the supposed free thylic bases, hich these powers are dormant, if not extinct. kland also describes* the salts of another base aining Mercury combined with Methyl, appa- ly in the same manner as Zinc and Tin exist e compounds last mentioned, but he has not ted the base itself.

70. The composition of these bases is very re- kable, indicating a constitution which differs any other type which we find among the salts. know no salts in which only two molecules, nselves severally of stylic power, have cohered orm a single style; still less do we know any substance in the isolated state. Neither do know, among our numerous complex bases, any rs, except the Metallothyles, which can be di-

A specific influence of the metal exhibited by them.

* Qu. Journ. Chem. Soc., vol. vi. p. 65.

vided into two members, both of which are ba
In the Sulfates [Sulfites], which may be take
the type of the greatest number of salts with c
plex styles, the two constituent molecules of
stylic member are O. and SO_3, of which O. alo
stylic. In the salts of Ammonia, H. and H_3N
the constituents of the base; of them, H. on
basic. In Cyanogen, C_2N, which most nearly,
stylic antilogue, approaches to similarity with
Metallothyles, and which is the only compo
style of which we know much, neither of the
components, C. or C_2 and N, are of stylic funct
The nearest approach to this pairing of the b
molecule, and perhaps a phenomenon dependen
conditions similar to those here concerned, is
doubling of the equivalent weight of certain b
metals, so that they form two series of salts,
one of which contains twice as much metal as
the other set. But in these remarkable carb
ous bases, a pair of molecules, each by itself
pable of saturating one molecule of style, are c
bined, and the compound has, quantitatively
greater neutralizing power than belongs to e
of them alone. Qualitatively, the new bases
sent us with the faculties of their constituents
modified and exalted condition. They seem
in this respect between the thyles and the pa
lar metals which are involved in them; combi
so to speak, features from the physiognom
both of them, with an energy of expression

* See note to § 264, p. 260.

ngs to neither of the parent bases. Thus the bases, like the Ethyloid-compounds, are oils gases, but they combine vehemently with the ogens, while the resulting salts conform re-rkably to the types of the metals which they tain.

271. This repetition of the properties of these tals in their thylous compounds is strongly sug-tive of the inference that they occupy the fun-mental position in these bases; if so, we must sider that the thyles here hold the secondary ition of adjuncts; so that we should write the ts of the metallothyles generally as Thy;Mb:St. In their salts the Thyles are adjuncts.

272. Now we have already concluded* that the hyloid Bases themselves are of a constitution ilar in form to that which is thus indicated for se more complex systems. We have found it st probable that the Thylistyles are of the form $_2H_2)_n$;H:St. We might be inclined, by the re-lar substitution of basic metals for Hydrogen, hich so readily occurs in the case of acids, to expect at such substitution might occur in the case of he thyles, and that we might find the fundamen-al Hydrogen of their salts, if not of these hypo-ases themselves, replaced by basic metals. Thus we should have looked for compounds of the form $(C_2H_2)_n$;Mb:St, and this certainly would have seemed a likelier formula than $(C_2H_2)_n$,H;Mb:St to one starting from the ground that the $(C_2H_2)_n$,H s itself basic. Such composition however has not The Hydrogen not replaced.

* See § 239.

been indicated by analysis as that of any sin
salts that have yet been examined; although on
two multiple salts seem to contain metals substit
for the Hydrogen of thylic systems. Thus, acc
ing to Zeise,* compounds in which C_4H_4 are
pended to Platinum in combination with Cl
obtained by the action of Pt,Cl_2 on Alcohol
would appear, from the composition which h
signs to the simplest of these compounds, th
formula is $\frac{C_4H_4;Pt\uparrow Cl}{Pt\downarrow Cl}$. Perhaps other such
tems and similar single salts may yet be discov
Another metallothylic base, which certainly
proaches in properties to these compound
Frankland, but of which the constitution and
bining habits are at present obscure, is the E
Ethyl of Löwig, $(C_4H_5)_3Bi$, or perhaps C_4H_5
We shall consider this and the somewhat sim
but still more anomalous, basic compounds of
timony with the thyles (Thy_3Sb), in a future p

The metals are anti-basic.

273. It is very interesting to observe tha
the metallothylic bases which have yet beer
scribed, except Hydrargyromethylium, C_2H
[Hermemethyl], which has not been isolated,
tain metals belonging to the Order of Antil
and that among them are the only metals (As
Sb.) which form well marked compounds wi
Frankland mentions† that several other metals
bine with the thyles. All those which he r

* Poggendorff's Annalen, b. xxi. s. 497.

† Qu. Journ. Chem. Soc., vol. vi. p. 66.

tances of this tendency are of the Antibase
. However, that one of this metallic group
general chemical properties mark it as most
allied to the metals we have here had occasion
ice, and which has affinities, indeed, both with
nd with Zinc, does not seem to form thylous
nations very readily. Schüler met with no
s in his endeavours* to form a Cadmium-
compound by acting on Iodide of Ethyl with
lic Cd. But other devices will probably in-
his metal to imitate its relatives in their de-
ent towards Ethyl and its congeners. Among
ules of metallothylic nature, we have how-
ately had one described, of which the metal
not belong to the Antibasic Order, but is a
type in another class. In this case however
etal itself enjoys antibasic properties in certain
ounds. This is the Plumbethyl $(C_4H_5)_3Pb_2$
wig.† I shall defer the consideration of this
ound for the present, as it differs in form from
f the compounds we have yet considered, in
ining two molecules of metal.

4. Even more curious than these basic metal- Synthyles comprise also Mefitithyles. Tellurethyl basic.
les are the analogous compounds of Ethyl
certain of the halogens, which have the closest
y to the antibasic metals, namely, with the
itifers,"‡ Tellurium, Selenium, and Sulfur.
ese and to the similar bodies yet to be dis-

n. der Chem. und Pharm. b. xxxvii, s. 43.
urn. für prakt. Chem., vol. lx. p. 304.
would give this name to the triad Family of which Sulfur

covered, containing other thylic molecules, the neral name Mefitithyles may be given. We include them with the Metallothyles under term "Synthyles." In none of the Metalloth which we have just been considering have we reason for supposing that the metal has in any of the compound any voltaic affection as res the thyle with which it is combined. But a stance which we have now to notice has thi markable peculiarity, that, though it has de basic properties, it is, in its origin, itself of th form. The Tellurethyl of Wöhler* is the Tell of Ethyl, C_4H_5:Te, obviously corresponding t sulfide Æ:S and to the oxide Æ:O; being obt by double decomposition between Telluride o tassium, K:Te, and the Sulfate [Sulfite] of contained in the double salt "Sulfovinate" o tassium $\frac{K}{Æ}\left\{\frac{O;SO_3}{O;SO_3}\right.$. But it was found by th coverer of this compound, aided by Mallet,† it has the properties of a base; forming salts form C_4H_5,Te:St, in which the stylic Tellu has passed over to the basic side. This is the instance in which the phenomena presented b set of compounds have warranted us in beli that such a passage of a stylic salt-member

is our common type, on account of the peculiar offensive which the members of this group confer upon so many c compounds.

* Ann. der Chem. und Pharm., b. xxxv. s. 111.

† *Ibid.*, b. lxxix. s. 223, and b. lxxxiv. s. 69. Qu. Journ. Soc., vol. v. p. 71, and vol. vi. p. 40.

side, really ensues on the combination of a
r quantity of halogen with a saline substance.
s been supposed that certain metals which
two series of salts, with different proportions
ogen, have, in their higher salts, a portion of
en transferred to the basic side of the system;
is hypothesis, the so-called "Uranyl" Salts
ligot, supposed to be of the form U_2O_2:St,
us an instance. But this theory is not esta-
d by facts as respects any of the metallic
In all such cases, too, the higher salts ap-
to contain feebler bases than the salts in which
ame metal is united with a smaller quantity of
en. But these Salts of Tellurethyl contain
e of energy far greater than that of Ethyl.
basicity of Ethyl does not appear under the
chemical reactions; its oxide is not alkaline,
not soluble in acids, it does not combine di-
y with the epistyles. But Tellurethyl, though,
cordance with its carbonous nature, it is oily,
nsoluble in water, is readily taken up by Ni-
Acid, just as would happen to a basic metal,
ing the solution of a true saline nitrate [ni-
] C_4H_5;Te:O;NO_5; from which H:S and
precipitate Æ;Te:S and Æ;Te:Cl. Again,
xide of the new base, which is obtainable by
le decomposition from some of its other salts,
y direct oxidation of the base, is soluble in
r, alkaline in reaction, absorbs CO_2, and even
aces, under certain circumstances, H_3N from
lts,—thus giving us evidences of the energy

of its basic member by new actions which none of the bases we have yet considered are competent to display. It is certainly strange that we should find these faculties conferred upon Ethyl by Tellurium, or on Te. by Æ, when neither of these molecules alone possesses more than the germs of them. Tellurium itself being of a type distinctly antagonist to the basic nature.

Selenium Ethyl also basic.

275. Selenium imitates its congener Te. in that its Ethyl-salt assumes basic properties,* so that we have several compounds of the form Æ;Se:S. These however are not yet so fully known as the similar bodies just mentioned.

The Sulfur Ethyl.

276. It has not yet been demonstrated that in the Sulfide of Ethyl, C_4H_5:S, [Ethy-Sulfade], the basic qualities are ever developed; but the established existence of a body having the composition ÆSS, corresponding probably to Æ;Te:Te, is suggestive of the notion that its constitution may be Æ;S:S, and that under certain circumstances ÆS may become basic. But since Sulfur is more decidedly halogenic than either of its congeners, we may anticipate that it would not so easily forego its stylic power as might Se. and Te., and that it might never more than indicate a tendency to a disposition which in them becomes an actual habit.

Mefitithyles and Metallothyles a distinct type.

277. These basic mefitithyles, together with the metallothyles of Frankland, belong to a distinct type, in which one molecule of thyle is combined with one of an elementary substance, metallic or

* Joy, Annal. der Chem. und Pharm., b. lxxxvi. s. 35.

genic. In the Kakodyls we have an instance base of another form, in which two molecules hyle are united to one of base. The Antimony Bismuth compounds, which have been men-ed,* and to which we shall return, are repre-ted, doubtfully perhaps, as bases of a third form taining three molecules of thyle for every atom metal. Löwig† has described a series of bases errible to the general head of metallothyles, but fering from all of these in the complexity which assigns to their molecules, and in the various portions which he finds between the quantities the two constituent members.

278. These are all compounds of Tin with Ethyl different ratios; they are obtained by the action an alloy of Sodium with Tin on Iodide of Ethyl. nong them is the base discovered by Frankland, ;Sn, containing a single molecule of each of the o constituents. Some of the others also pre-ted themselves in the free condition; the oxides d some other salts of all of them were obtained. ese salts contain but one atom of halogen for ch molecule of base, however complex the base elf may be. The various properties presented the oxybases of this group are remarkable, as dicating important differences in the constitution their bases. We may compare them briefly ith each other for illustration of this point. A bular form will serve this purpose well. In the

Kakodyls are of another type;

* See § 272, p. 282.

† Annalen der Chem. und Pharm., b. lxxxiv. s. 308.

first column of the following table are numbers for convenience of reference; in the second are the names given by Löwig to his new bases. These are founded upon the analogy which their constitutions present respectively with that of the molecules C_2H_2, "Methylen;" C_4H_4, "Elayl;" C_2H_3, Acetyl; C_2H_3, Methyl; C_4H_5, Ethyl. Löwig supposes the Sn. in his several bases to represent the C. in these groups, and the Æ. of his compounds to correspond to their H. The third column indicates the composition of each base; in the fourth are stated some properties of the bases; in the fifth those of the Oxides [Oxades] are indicated.

perhaps belong to two types.

279. It will seem probable, I think, from an inspection of this table that we have here two different types of compounds, which are respectively represented most perfectly by the bases and oxides of the horizontal lines 1 and 5. The bases of the first of these kinds seem to be oily liquids, with solid, non-volatile Oxides [Oxades], which on the one hand resemble the oxide of Tin in their deportment, being weak oxybases with an epistylic tendency. The bases of the other kind are not certainly known to exist in the free condition, and perhaps—I think, most probably—cannot be isolated without decomposition. Their oxybases are of habit very different from the others, being strong Alkalies, in which the tendencies of Tin, as well as of the hypobases, have disappeared, and a new class of properties are presented to us. These properties of alkalinity, which

			pitates metallic Ag. from its Salts.	water and in Alcohol, not in Ether; is precipitated from its salt-solutions by H_3,N and by $K:O;H,O$, which in excess redissolves it.
2	Methylen-Stannethyl	$(C_4H_5)_2,Sn_2$	Unknown in separate state.	Similar to No. 1.
3	Elayl-Stannethyl . .	$(C_4H_5)_4,Sn_4$	Similar to No. 1.	Similar to No. 1, except that its Salts are insoluble in $H:O$, but soluble in Ether and in Alcohol.
4	Acet-Stannethyl . .	$(C_4H_5)_2,Sn_4$	Not prepared pure; isolation doubtful.	Similar to No. 3 (Iodide crystalline, odourless).
5	Meth-Stannethyl . .	$(C_4H_5)_3,Sn_2$	Similar to No. 4.	Known as Hydrate, which is crystalline, melts to an oil, volatile; its vapour, like H_3,N, fumes with that of $H:Cl$; soluble in $H:O$, but more easily in Alcohol and in Ether; has a burning taste, and alkaline reaction; absorbs CO_2; forms Salts, which, except that with N,O_5, are crystalline, and soluble in Alcohol and in Ether; separates $Mg:O$, $Zn:O$, etc., and H_3N from their Salts (Iodide a mobile volatile oil, of penetrating odour).
6	Æth-Stannethyl . .	$(C_4H_5)_5,Sn_4$	Not prepared pure, but supposed to be separated from its Salts by K. or Na.	Hydrate, similar to No. 5, but not quite so strong an Alkali (Iodide a thick oil).

O

, in which its molecule is doubled and quad-
d, without increase of saturating power. They
to present us with new and very remarkable
rations of the principle of dimerized mole-
, to which I have already alluded, and which
all again encounter.

0. Löwig* has more recently described another Plumbethyl.
llothylic base, which corresponds in form to
5 in the above table, and which, like that
ompound, has not been isolated. This is his
bethyl, $Æ_3Pb_2$, to which I have already al-
.† I mention it here to point out this ana-
but must again defer the discussion of it, as
sider that it also really belongs to another
of compounds, which we have next to con-
, and in connection with which I shall discuss
This base has not been isolated. If it and the
gous tin-molecule should prove to be sub-
es, they will be the first instances known of
ases of the "Ammonium" type (B_4Ast) that
been discovered. Their existence is, I think,
obable.

1. All these Synthyles seem to be instances
e formation of compounds under the law of
xation. Just as Ethyl itself appears to be
ituted as C_4H_4,H, in which C_4H_4 is the ad-
to Hydrogen; so, for example, in Zincethyl,
l itself seems to be annexed to Zinc thus,—
$_4$,Zn, or $C_4H_4.H,Zn$.

* Journ. für prakt. Chem., vol. lx. p. 304. † See § 273, p. 282.

CHAPTER IV.

OF THE FIRST ORDER OF BASES.

Autobases.

282. We have now surveyed a set of bases which, though not strictly analogous to our first Order of Styles,* yet compose an Order which in some sense corresponds thereto. The common attribute which unites all these bases is not, as in the case of the Styles to which I would compare them, that of isolability, for many of them have not yet been obtained in the free state. It is somewhat difficult to define the tie which connects them together; it consists however in a probability that they may be all isolated, and in the fact that they do not split into definite submembers to which we can assign special functions in the structure of the bases. Each of them is a molecule having of itself basic properties; they are therefore Autobases,† and resemble in this respect the elementary or simple bases. This term "Autobases" may indeed be used as distinctive of a group which includes the simple bases and all complex bases of the kinds

* See § 219, p. 202. † See § 84, p. 68.

ich we have hitherto considered. The Order is y much more numerous than our first Order of yles, which consists of only the elementary ha- ens and the compounds Cyanogen and Mellone. e may call the salts having bases of this group Antobasistyles."

283. This first Order of Bases includes a large mber of Geogens, the Zoogen Hydrogen, and e numerous complex molecules, containing Hy- ogen and Carbon, which we have called Hypo- ses, and the compounds of some of these (certain the Thyles) with a few Geogens and Halogens. e Order of Autobases may perhaps be divided ost satisfactorily into these three families:— Subdivisions of Auto-bases.

1. The Elementary Bases.
2. The Hypobases.
3. The Synthyles.

erhaps however Hydrogen ought to be included nong the Hypobases, with certain of which it is ost closely related; in that case the first family ould consist of the Metallic Bases.

284. Now, just as we require, for the salts cha- cterized by the different Halogens, terms which press this fact of their constitution, so we should ve words which similarly refer to the basic part their structure. We have reserved the conso- nt *d* for the designation of the salts of the Auto- yles.* So we may take the letter *b* to denote, in e final syllable, the salts of the Autobases; and e letter *a* may indicate that there is but one mo- A nomen-clature for them.

* See § 67, p. 56.

lecule of base in each such compound. As we not require two distinct specific names for e compound, and we have agreed to form one-wor terms for the salts, with the name of the base f followed by that of the style, which gives its minal consonant to the word, we need not there construct specific names with the distinctive *b* in final syllable. But the general terms of this f will be very useful, as substitutes for the lo words, involving the syllable "style," Thyli-st Ethy-style, etc. Thus, as the Halades are salts having any halogen for their styles, the ades those having Oxygen, etc., so the "A basabes" will be the salts having any autobas their base:—

"Hydrabes"	Hydrogen.
"Metallabes"	any Metal.
"Thylabes"	any Thyle.
"Synthylabes" . . .	any Synthyle.
"Ethylabes"	Ethyl.
"Kalabes"	Potassium.
etc.	etc.

CHAPTER V.

OF A SECOND GROUP OF BASES.

SECTION I.

Of Ammonine.

5. We have now to consider the complex
of other types, and to seek the law on which
vastly numerous molecules are constructed.

6. The so-called salts of "Ammonium" having
, of all those containing complex bases, the ear-
and for ages the only ones, that were known,
still those most commonly met with, and
next, in degree of complexity, above the
typical of the hypobases, come naturally next
r notice. And this order is the more logical,
cent discoveries have shown that a great num-
of other complex salts are constructed upon
model of which "Chloride of Ammonium,"
N;H:Cl, is the simplest form. Now the first
which strikes us about the "Ammonium"
is the remarkable fact, that the base, which
pies the positive side of their system, is not
n in the separate state. And the isolability of

The Salts of "Ammonium," NH_4, not a body.

haves "ganz wie ein organisches Radical," by which he means to say that it acts as a base. If this were all that we could learn about it, we should, perhaps, be justified in concluding that its true constitution is C_4H_5,Bi', not a tridactylous body, as it is usually represented, but an analogue of C_4H_5,Te and C_4H_5,Sn, which are truly and singly basic. At present we cannot tell whether it belongs to the "Stibethyl" or to the Tellurethyl type, or whether it is intermediate between the two. But though, on the one hand, the formula that has been given to Bismethyl may have to be divided by three, and though, on the other, we are at liberty to split the molecule of Sb. in the formulæ of Stibmethyl and Stibethyl into Sb'_3, yet we cannot separate the formulæ of these latter compounds, when they take basic functions, into three. For, whatever may be the habits of the basic Bismethyl as respects the number of atoms of halogen with which it will combine, we know that the basic Stibmethyl takes two stylic molecules to form its salts. So that we shall gain nothing by trying the formula Thy,Sb': this would bring us only to $(Thy,Sb')_3:O_2$—no nearer the constitution of a true salt than we were before.

Instances of changes of structure.

330. We must suppose that, while Thy_3Sb represents the constitution of our epibasic molecules, their particles shift about and rearrange themselves in another form, when the compounds become basic. Instances of such change are not wanting, especially in bodies containing Nitrogen,

aving no faculty of combining with styles, but that has an eager attachment for hydrostyles, with hich it combines, forming salts having a very otent base. Thus it combines with water, con-erting, during its union therewith, that body into most powerful Alkali. Nevertheless, in accord-nce with the usually weak combining tendencies f our typical oxybase, it is very easily detached rom that liquid, even by very moderate heat.

288. Now here we cannot escape being reminded, by the habits of this substance, of the behaviour of certain bodies with which we have been dealing on the other side of the Salt-Idea. We there found the free epistyles—for example, those with Oxygen

Comparison of the gases NH_3 and SO_2.

hich this highly eminent author, of whom I speak with defer-nce, uses the name,—meaning H_3N,—is not a base, in any ac-eptation in which that word has been defined. No true answer ould, of course, be given to a fallacious question. But the solution ffered, in the passage to which I refer, is founded upon a distinctly ntrue assumption, namely, that N. is "negative" in the same ode in which Cl. has this character, that is to say, voltaically; nd that thus in H_3N, three atoms of H. are severally and col-ctively basic to the—as I must interpret the language—stylic ;; and that an excess of basicity of the H., due to its third atom, nfers the supposed positive power on the entire compound. Graham's Elements of Chemistry, 2nd edit., vol. i. p. 207.) Not aly has N. never been proved to be negative in this substance, but n compound is known in which it has such a position; and further, has been proved that in this particular group of atoms none either positive or negative. Faraday thus concludes his account f an attempt to subject H_3N to voltalysis:—"The Ammonia, hen, was not electrolyzed. . . . I know of no experiment with ny compound of Nitrogen which shows the tendency of this ele-ent, under the influence of the electric current, to pass in either irection along its course." (Researches in Electricity, § 748.)

for their characteristic—themselves destitute of stylobasic affection, yet endowed with a peculiar chemical energy, by virtue of which they combine with water, converting that substance, during their union with it, into vigorous acids; and—on the voltalytic decomposition of the water thus complicated—as the epistyles are always evolved on the negative side along with the Oxygen, so the H_3N always comes off on the positive side together with the Hydrogen. With some of these epistyles too, the resemblance to our Ammonine is rendered the more striking by their accordance in physical peculiarities. Let us instance the epistyle commonly called "Sulfurous Acid," SO_2 [Oxysulfere, or Sulfere], and let us compare it with Ammonine. Both these substances are, at ordinary temperatures, gases, but liquefiable by pressure and cold; both have a peculiar effect of pungency, distinct from that of odour, upon certain nerves of the olfactory organs; both, as has been said, are of themselves voltaically neutral as entire substances; nor are either of them constituted, as respects their parts, by the voltaic attachment, not being susceptible of decomposition by a current of that force. Yet each has been confounded, by reason of its peculiar energies, with true salts, the one with alkalis, the other with acids. Both gases are greedily absorbed and retained in solution by cold water, with which, at a low temperature, each forms a crystalline compound; but both are expelled again from that combination by a heat far below the boiling point of

r. The water, so long as it retains the one,
reddened litmus-paper blue; with the other
ldens the same blue paper: in the one case it
ecome a strong alkali, in the other a powerful
Further, if the two gases are together passed
the same water, they remain in a much closer
of combination therewith, forming a crystal-
ubstance which is a true salt, solid at ordinary
eratures, and which under the voltaic current
t asunder, all the Hydrogen and all the Am-
ne passing to the cathode, and all the Sul-
s Acid [Sulfere] going with the Oxygen to
node. Now I scarcely see how any mind, not
cupied with some antagonist theory, can resist
nference from these facts, that the two bodies
nited to the water in similar modes, which
ver are not the same, because they join the
ubstances to opposite sides of the compound.

9. I feel compelled to conclude, in short, that Ammonine the antilogue of the Epistyle SO_4; as the epistyle is conjugated to the Oxygen of ater, so the Ammonine is annexed to the Hy-n of that liquid, by an analogous, or, as it is in posite sense, we should say, antilogous attach-
And, by parity of reasoning, I think we
conclude, that in the Salts of Ammonium with
styles, the Ammonine must be supposed to be
ed to the original Hydrogen of the hydrostyle,
position exactly parallel on the other side, or
gous to that which the epistyles occupy with
t to the Oxygen of the oxybases to which they
e. For "Sulfurous Acid" [Sulfere], though

differing in physical characters from the great number of the epistyles, may be taken, chemical as fairly representing their general behaviour. (these grounds then, just as I hold that "Hydra Sulfurous Acid" [Sulferic Acid, or Hydrosulfe should be written as $H:O;S,O_2$, I consider t we must describe Ammonia as $H_3,N;H:O$. And we shall include it under our comprehensive not of conjugated waters, in which one of the eleme of the Endohale H:O is complicated, not sub tuted, by another molecule. And of the other s of the same complex base, the Chloride [Chlor must be $H_3,N;H:Cl$, and the Sulfate [Sul $H_3,N;H:O;S,O_3$. Thus this last salt, whic perfectly neutral body, like water, and in whic chemical tensions seem to be satisfied in a re blishment of the polar equilibrium, is represent a perfectly symmetrical formula. The additi either H_3,N or S,O_3 to the nuclear H:O, dis the chemical balance of the system, and sets it a state of potential energy, which can be al by no other simple process but by the presen to it of a body of the same nature as the ot these supplementary molecules.*

* We do not know that the voltaic relation of the H. (to the O. is disturbed by the addition to it of either H S,O_3; on the contrary, we know that in each case the point remains the same, and that on voltalysis the Oxy Hydrogen take the same directions, and require, to effe severance, the same equivalent of force after as before the tion of either adjunct. But we know that the force wh Hydrogen or Oxygen respectively of simple water could

290. Hence I conclude that whatever relations such bodies as S,O_2 and S,O_3 and the like bear to the combined Oxygen of the oxybases to which they attach themselves, and to the complex styles which, with it, they constitute, just the same kind of relation does H_3,N bear to the Hydrogen of the hydrostyles to which it adheres, and to the complex base which with that molecule it constitutes. This substance should, like those its antilogues, have a generic term derived from this function, so as to express this parallelism of the two kinds of bodies. As, therefore, I have called the corresponding bodies on the stylic side generally, Epistyles,* I would bestow the term Epibase upon the substance H_3,N, and upon any other bodies which play the same part in composition.† Hence we may set up this,— and therefore an Epibase.

the other direction away from its fellow of the pair is, in either case, enhanced by the annexation to it of the new molecule. This phenomenon reminds us irresistibly of the two processes of electric and of magnetic induction: and may confirm us in the belief that the peculiar forces which unite H_3,N and S,O_2 to the H. and O. of water, are the same in kind but opposite in direction, like the two components of electricity, of voltaism, and of magnetism.

* See § 75, p. 66.

† That bodies having the form and function of H_3N are of a nature polar to that of the epistyles, is further evinced by the fact that they combine with each other, in many instances directly, without either substitution or elimination of any part of either component. Thus H_3N unites with CO_2, with SO_2, and with SO_3 and with several epistylic metal-halogen compounds, and Aniline ($C_{12}H_7N$) unites with the epistyle C_4H_3,O_3. But the bodies resulting from this kind of union are not salts, in the only

Epibase defined.

291. *Definition* 16. An Epibase is a molecule, which, when in combination with simple salts, forms salts having a complex base. An epibase, then, is a particular, the second, case of an epipole.*

Its salts termed Epibasistyles, etc.

292. This, then, is a particular case of the complexity of the base of a salt,—namely that which consists in containing an epibase. We may require a term to designate such salts as have this special complexity, as distinguished from any other form with which we may meet. Thus, then, any such complex basistyle as contains an epibase, may be called briefly an "Epibasistyle:" and any such as contains both an epibase and epistyle, may be called an "Epibas-epistyle." We shall also require a term to express the functions, firstly, of the hydrostyles to which H_3N and its similars attach themselves; and, secondly, of the Hydrogen of such hydrostyles. We may call such molecules as the

sense which has ever been defined for the term: there is no proof whatever that they are voltalytes; that the epipoles of which they are made up, or that, (in any instances in which a direct union of the two occurs without a manifest decomposition and recomposition,) any other two parts, into which the whole compound can be divided, are connected together by the stylobasic attachment. They are analogous to salts, but of another type. I would call such compounds, of an epibase with an epistyle, "Haloids." I would form the name of each of these bodies by prefixing the name of the epibase to that of the epistyle united with it, substituting, for want of a better symbol, an *s* for the *r* of the final syllable of the latter, to denote that the body is a haloid, and not a salt,—a salt of an epistyle being denoted by a *t*. Thus $H_3,N;C,O_2$ would be Nitrino-carbese; $H_3,N;S,O_2$, Nitrino-sulfise; $H_3,N;(S,O_2)_2$, Nitrino-bisulfese.

* See § 75, p. 66.

...cted on totally different
...deavoured to indicate.

V.

Species of Epibases,
Salts.

...e the facts that in the ...e epistyles, both the ...are variable. It be- ...press this in our no- ...ust be constructed in ...cases in which there ...to be named. Our ...ure and in function ...should therefore be ...tibases, then, were ...names for the other ...ir antilogues the an- ...for the terms we now ...ng this part of the ...penultimate place in ...re than one, will de- ...compound. As, in ...have oxygen for their ...prefix that states the ...style,—so, when hy- ...f an epibase, we may ...otype metabase from ...The vowel in the last

Nomenclature of epibases explained.

similar part. But of later years a flood of lig
been thrown on the subject by numerous
veries, chiefly by those of Hofmann. The
ary compound H_2N need no longer be look
by the most hopeful experimenter, or requi
the most earnest theorist, to explain the my
of basigeny. A great number of carbonou
stances which, under treatment with acids, g
salts, have been made known to us in moder
These have been included under the commo
"organic bases." It is probable that two
classes of compounds have been, and are sti
confounded together, namely, epibases an
bases; there being no true bases among the
to which this term is most commonly res
Perhaps it would not be very easy to go t
all these, and by aid of the published descrip
them to separate the collection into the two
which it comprises. So much confusion
tended the use of the terms Base and Alkalo
it is sometimes very difficult to ascertain, ev
the aid of the specified salt-formulæ, whe
author is describing by one of these words
base or a prostylobase. Most of the artifici
pounds called "bases" seem to be epibases
of the products of organic life that are refe
this head are probably oxybases. Among
however, there are some, of whose constitutio
is no doubt; instances of these will be suffici
my purpose. Bodies of this class are general
volatile solid substances. Of the other m

rous class, Aniline, $C_{12}H_7N$, is a famous example, d one of the earliest known to us. It is with s latter kind that we have to do at present. They e, for the most part, volatile oily bodies, whose solubility in water is proportionate, in some mea- re, to the percentage of Carbon which they con- in. They are distinctly analogues of H_3N, uni- ng directly with acids, attaching themselves as pibases to the Hydrogen of these systems. They robably differ from each other in epibasic energy ust as we have among epistyles a wide range of pistylic attachment between the properties of SO_3 nd of CO_2.

297. Aniline, though nearly insoluble in water, self absorbs and dissolves more than enough of at liquid to form the oxybase $C_{12}H_7,N;H:O$. et it is very easily separated by heat from this ater, so that its attachment for this probasistyle not much stronger than that of H_3N. Even yet e constitution of many of these zoogenic epi- ses is not known. All of them that are pro- ced from organic compounds, all of them that ere known up to a very recent period, contained itrogen. Most of them contained but one atom of at element. We long remained quite in the dark to the molecular structure of any of these com- unds. Hofmann had, ten years ago, informed us a fact in the physiology of Aniline, which, ough a negative one, has so important a bearing the constitution of the class of compounds to hich this body belongs, that I must here mention

Aniline never electrolysed.

it. "An electrical current, obtained from four pairs of a very powerful Bunsen battery, did not produce the least decomposition [of Aniline], although the platinum-points became red-hot when in contact under the liquid."* From this we learned that this epibase, in one significant point, agrees with H_3N, which, under Faraday's hands, refused, not being a salt, to submit to voltalysis.† Still for a long time we knew nothing positive of the constitution of this or of any of its congeners. But now, as I was saying, modern researches have not only vastly increased our list of them, but have given us an insight into their structure. Wurtz had shown,‡ that by the action of Potassa on the "Cyanic Ethers" [Thyli-cyates], compounds could produced precisely analogous to Ammonine, both in properties and in composition, but each containing a hydrocarbon group instead of one of the atoms of H. of the original epibase. The tendency of this remarkable discovery was, perhaps, rather to confirm, in the minds of chemists, the prejudice in favour of the reality of the unknown body H_2N, which might be supposed to have combined, for example, with Ethyl (C_4H_5) to produce the epibase "Ethylamine" $\left(\begin{matrix}C_4H_5\\H_2\end{matrix}\right\},N\Big)$.

Hofmann's results.

298. But Hofmann, reaching, in the course of his long researches into the constitution of the Zoo-

* Phil. Mag. (February, 1844), vol. xxiv. p. 125.

† See the note to § 287, p. 296.

‡ Qu. Journ. Chem. Soc., vol. iii. p. 90.

s Bases, a deeper point in the mechanism of compounds, showed that the two other atoms ydrogen in our prototype epibase could be ed, with equal facility, by thylic hydrocarbon ules.* So that there was no more necessity or for the supposition of such an entity as H_2N, there was for believing in a fictitious HN. rther showed that the molecules thus inserted e epibase may be all of the same or all of nt composition: thus presenting us with the ated epibases, of which his "Methylethylophe-

line" $\left.\begin{matrix} H_2C_2,H \\ (H_2C_2)_2,H \\ (H_2C_2)_2(C_2)_4,H \end{matrix}\right\}$N. is a telotypical

ple. Each and all of these numerous bodies found to have the faculty, like H_3N, of at-g themselves to hydrostyles, and so of form-mplex salts, in which but few could doubt hese bodies were united to the Hydrogen of drostyle in the sense that they were placed on me voltaic side of the compounds. The steps s process of experiment are most interesting, fford one of the most beautiful examples of ific induction, that are to be found in the re- of chemistry.

). Hofmann first found that by treating ne with C_4H_5:Br., or another thyli-bromade, nd a second molecule of Hydrogen in the r compound could be replaced each by an lent of C_4H_5 or of a homologous hydro-

He replaces the Hydrogen in Aniline.

* Phil. Trans. (1850), part i. p. 102.

thymethynitrine. So we shall have a set of Phosfines. Thus H_3,P, Hydrophosfine, or specially Phosfine; for $\left.\begin{matrix}Me\\H_2\end{matrix}\right\}$,P, Monomethyphosfine; Me_2,P, Methyphosfine. And Stibines: thus, $Æ_3$,Sb, Ethystibine; and $Æ_3$,As, Etharsine.

These terms abbreviated.

339. Most of these terms may be very conveniently shortened by representing the Antistyle of each substance by a consonant instead of a syllable, thus *n* may denote nitrogen; *ph*, or, much better, *f*, phosforus; *sb*, antimony. Other superfluous syllables may also be dropped from the metabasic parts of some of them. Thus we should have the terms Hydronine, Monomethynine, or Monomenine, Dimethynine or Dimenine, Monofenine, Fenethymenine, Monomefine, Methyfine, Ethysbine, etc. The adoption of such words as these for classical terms, need not banish from current service as occasional synonyms such conventional names as Ammonine, Aniline. Again, the number of metabasic molecules of H. in an epibase is a very important condition of its anatomy. There are three groups of carbonous epibases, derived from H_3N, and distinguished from each other by the quantity of the H. of the prototype, which has been replaced; this quantity amounting to one, two, and three atoms respectively, in the three groups. The members of these groups are sometimes called severally "amidogen bases," "imidogen bases," and "nitrile bases:" these terms are inadmissible in our system. But we may form

t antilogue of SO_3; the former consists of ogens, the latter of two halogens. Of one of of these pairs of elements there is but a single alent; of the other there are three. The se- element, in the case of the epistyle, is, in all ormal cases, the same as the prostylic halogen ich the epistyle adheres in forming complex The analogous condition holds good as re- the second element in our typical instance epibase class. It is to basic hydrogen that onine usually attaches itself: hydrogen is the nt which is repeated in the epibase. Further, every instance the second member of an epi- consists of a stylic molecule, simple or com- , so we shall find that the secondary mole- of an epibase of this form are generally true simple or compound.

. By analogy, then, we may apply to the se- kind of molecule in our epibases the same al term which we have applied to the corre- ing part of the opposite compounds. Let us denote those parts of an epibase which are ented in Ammonine by three atoms of Hy- n, by the word "Characteristic." Let us re- er however that, as we have just seen in one ce,* in epibases with three molecules of Cha- istic, all three may be different. So far as we this cannot be the case with epistyles; in- the instances are rare in which all the atoms racteristic in an epistyle are not all the same.

Nomencla- ture may be founded thereon.

* See § 298, p. 306.

It will be observed that the differences betw
the materials, out of which the two kinds of e
poles are built up, are such that differences in
law of their construction only indicate the n
perfect conformity with the harmony of the
mentary bodies. The epistyles have for their
racteristics the members of the class of elemen
halogens and Cyanogen. Seven of these halo
(all except Fluorine and Phosphorus) have th
culty of entering into the composition of epis
in this capacity. Again, a great variety of bodi
all of the halogens except Fluorine and Oxyg
numerous metals, two—perhaps all—of the
zoogen elements, and a vast number of com
molecules made up chiefly of the zoogens, oc
the position of antibases in these epipoles o
volta-negative side. This diversity correspon
the diversity of species which prevails in that
of the elementary circle out of which the epis
take their rise. The halogen-class contains
members, while the zoogen-class contains but t
On the other hand, the complex bases owe thei
poles chiefly to the class of the zoogens. By fa
greater number of these bodies have only Hydr
or compounds of Hydrogen and Carbon for
Characteristics. Again, but few other bodie
sides Nitrogen occupy in epibases the place w
corresponds to the antibase of the epistyle.
ample material for variety in the epistyles is affo
by the variety of elementary species, which
enter into their constitution in either capaci

antibase or as characteristic. So that the complication of their structure, by the introduction of different molecules into the characteristic of the same epistyle, is unnecessary for the production of the requisite diversity. But in our corresponding epibases, the materials for the construction of which are so few, this variety is most beautifully attained by the admission of different characteristics into the same compound.

Nuclear character of the Nitrogen.

303. The position of Nitrogen in Ammonine and in its homologues, in which it seems to act as the nucleus-point of attachment for the coherence of the characteristics, and the function which it seems to fill as the copula by which these molecules are linked to the fundamental Hydrogen, is very remarkable. It occupies in its own system a position similar to that which Sulfur fills in the epistyles S,O_2 [Sulfere] and S,O_3 [Sulfire], and which N. itself takes in the epistyles N,O_3 [Nitrire] and NO_5 [Nitrure]. This nuclear situation entitles it and other molecules which may replace it to a distinct denomination. Now, as the antibase in the epistyles somewhat resembles a base in its relation to the halogen atoms which are combined with it, so this Nitrogen acts towards the molecules with which it is associated in the epibase, and which in Ammonine and in the thylous epibases of Wurtz and Hofmann are themselves of basic property, somewhat as the style of a salt acts towards the base, being in a manner, though not voltaically, polar to its fellows. I would therefore call such

Nitrogen or other similar molecule an "Antistyle," defining the term thus:—

Definition of an Antistyle.

304. *Definition* 19. An Antistyle is a molecule which in combination with a molecule or molecules of the base kind forms an epibase.

305. The Antistyle is thus a particular case—the second—of the antipole.* The analogy of the antistyle to the style of a salt places this molecule among the "Styloids."†

These antistyles are of the nature of halogens.

306. The relation which the antibases bear to the bases is perhaps one of nearer affinity than that which the antistyles of the epibases bear to the true styles. The similarity between the former two kinds of bodies is in some respects so close that chemists seem often not to perceive their difference; yet, on the other hand, when the distinction in their functions is once recognized, it appears so strongly marked as almost to amount to a direct antagonism.‡ On this account I took the name Antibase, as being indicative both of that similarity and of this opposition. But the co-ordinate analogy in combining tendency, and contrast as respects posi-

* See § 91, p. 74.

† See note at p. 88; also p. 73 and note to § 113, p. 91.

‡ Thus Berzelius divided one of his primary sections of the class of metals into two groups, which he called respectively the volta-positive and volta-negative. No metals, unless perhaps Arsenic, in some compounds, are truly volta-negative. The class to which this term was given consists of metals which have antibasic properties. His volta-positive class contains those whose basic powers are decided, but of inferior degree; the strongly basic metals being set apart in his system under a mineralogical denomination.

xx in salts, between the antistyle of the epibase
d the style of a single simple salt, though not
ite so obvious, are equally real: even so much so
at an antistyle has been supposed to be stylic to
fellow-molecules, the characteristics of an epi-
se.* Thus, as several antibases, such as Tin and
romium, also serve as bases, so we have, as we
all see presently, the halogen Phosphorus, though
yet no others of its class, and that one of the zoo-
ens which most resembles the halogens, namely Ni-
rogen, occupying in epibases the antistylic place.

307. Further we shall observe that the three molecules, which complete the single† epibases of this type, by combining with the antistyle, are, in early all the instances in which such compounds ave been artificially constructed, true autobases, nd so maintain the antilogy between the epibase nd the epistyle, in which latter the autostyles ombine with the antibase. For this reason, which e must more closely examine, I would apply to ie three Hydrogen atoms of Ammonine, and to l molecules occupying a similar position, the term Metabases,"—which I would thus define.

The metabasic molecules are autobases.

308. *Definition* 20. A Metabase is one of the primary molecules, which, in combination with an antistyle, form an epibase.

Definition of a metabase.

309. Thus a metabase is the antilogue of a me-

* See note § to 287, p. 296.

† We shall hereafter have to notice compounds of another, but ed form, the Double Epibases, in which this rule does not hold d.

Ag., Pd., Pt., Ir., or other metal substituted for an equivalent amount of Hydrogen; but I believe that hitherto no evidence has been offered of the production of any such compounds. And till this has been accomplished, no one has any right to represent one of these complex salts as being of the form $N\left\{\begin{matrix}B_3\\Mb\end{matrix}\right\}$:St. For until we meet with such compounds, we can have no doubt about the rational constitution of any such salt. We may be sure from the modes of construction and of decomposition of every such salt, that has been hitherto formed, that they are all truly represented by the formula $B_3,N;Mb:St$. To adopt the other formula is positively to take a step backwards in science, and to profess a doubt where we possess certainty. When, for instance, we shall meet with such a body as H_2Pd,N, and shall find that on

assigning to them the composition $TiCy + (Ti_3N)_3$, (Qu. Journ. Chem. Soc., vol. ii. p. 352) ought to be represented as a true salt of the form $\left.\begin{matrix}Ti\\Ti_4N\\Ti_4N\\Ti\end{matrix}\right\}$N:Cy. In passing, I may be allowed to remark that the general physiology of this compound scarcely seems to resemble that of a substance containing Cyanogen. Is it not a compound of $(TiN)_2 + (TiC)_3$, or of $Ti_3N_2 + Ti_2C_2$? Are any cyanides, except perhaps those of the strongly basic metals, stable at the high temperatures of the blast furnaces? Is not the formation of this compound owing to the decomposition of TiCy in presence of Fe, which carries off a portion of the C.? What becomes of TiCy if subjected by itself to a white heat? We learn from Wöhler that Ti_5N_3, and not TiCy, is produced by igniting Ti,O_2 in a stream of H:Cy or of Cy.

Section III.

Of Antistyles.

3. Nitrogen, as we have seen, and shall have Nitrogen the telotypical antistyle.
er occasion to remark when considering the
ases, is the telotypical antistyle, filling the
ion of this place in the typical epibase H_3,N,
n an almost infinitely great number of other
s of epibasic character. For a long time, in-
until lately, no other element was known to
te Nitrogen in this behaviour.

4. Since the great advance made by Hofmann* Other antistyles now known, as,
e analysis of Ammonine towards the synthe-
the class of epibases, our notions of the com-
nsiveness of this form have been much in-
ed by other discoveries. We had thus learned
the metapoles of the epibases were variable.
now know that their antipole also admits of
ty, to a small extent, of which we have not yet
tained the limits.

5. It had long been known that the gaseous Phosphorus,
ound of Phosphorus with Hydrogen differs
remarkable manner from the compounds of
other halogens with that element. It does
pitate certain basic metals, Cu., Pd., Pb., Hg.,
perhaps Ag., from their solutions as true
phides, thus seeming to act the part of an
Nevertheless its composition, being H_3,P,
not H:P, forbids us to consider it as a true

* See § 298, p. 306.

Kane's theory of certain salts of Mercury.

347. We are acquainted with two or three seri of salts of this metal, of which the composition most easily expressed by assuming that they conta a complex base. There is, however, considera obscurity about these compounds. They are suffi ently important to demand a special considerati It had long been known that the precipitat formed by adding H_3N to the soluble salts of H [Herminum], contained Hydrogen and Nitrog they had been supposed to contain H_3N. K examined these compounds, and assigned to t a constitution which, according to the syste notation I have used, would be represented $\frac{Hg' \uparrow N H_2}{Hg' \downarrow St)_n}$. This notion was closely connected the theory, maintained by this chemist, that

and its constitution seems to be $\frac{Hg' \uparrow O; N, O_2}{C_4 Hg'_6 \downarrow O; N, O_2}$. This $\overline{(H \downarrow O)_2}$

pound, considered in connection with the salts which w now to examine in the text, is certainly of the highest in and is suggestive of a wide range of new combination § 273, p. 282.

* In conformity with the plan I have adopted in this w of denoting by an accent appended to the symbols of the the fact that they are present in a lower proportional q than in certain other compounds, or than they are usual posed to affect,—I here represent by Hg′ that molecule w now commonly marked by Hg., consisting of 100 parts by of the metal, while I put Hg. in the place of the Hg_2 of th nary modern notation, and would be understood to m this plain symbol, that the metal is present with the equ weight 200.

$_3$P;H:St. Here we have Phosphorus distly acting the part of an antistyle.

316. The next steps, for which the point had been Antimony, cated by these facts, and by the collateral disco- of Frankland, which we have already noticed,* e the formation, by Löwig, Schweitzer, and dolt, of the compounds called Stibmethyl and ethyl,† which are true epibases, having, respecly, the constitution $(C_2H_3)_3$,Sb and $(C_4H_5)_3$,Sb, having the metal antimony for its antistyle. t these remarkable compounds are not bases Kakodyl and the metallothyls which we have re discussed,‡ but epibases analogous to H_3N, mply proved by the formation of certain com- salts, in which they are combined with probayles; these salts having the form B_3,Sb;B:St. shall have to consider these in a future page.

317. But these new epibases are stated to have singular property of also behaving as actual very powerful bases, that is to say, of formsalts by combining directly with the halogens. ir reputed basicity, however, is attended with anomalous peculiarity, which distinguishes these ies from the other metallothyles, as well as n all other bases,—namely this, that in all ir salts they take two molecules of style instead ne. I think, however, that these compounds, n thus acting as bases, must have a molecular

* See § 269, p. 278.

† Qu. Journ. Chem. Soc., vol. v. p. 66.

‡ See § 269, p. 275.

constitution different from that which they possess as epibases.

Bismuth, 318. The same chemists who discovered these highly interesting links in the chain of the affinity of compounds have also described bodies to which they assign the constitution $(C_{10}H_{11})_3$,Sb and $(C_4H_5)_3$,Bi; the former containing Amyl $(C_{10}H_{11})$ combined with Antimony, the latter Ethyl combined with Bismuth. But we are not yet fully informed whether these substances are endowed with the epibasic attachment. Analogy would lead us to expect that they—at least the former of them—would exercise that function. Hitherto, however, we have only been told that they resemble the Antimony compounds just previously mentioned, in that they play the part of bases towards the halogens.

Arsenic, 319. Very recently, again, Landolt* has added a most interesting member to our series of compounds of this kind by the discovery of his "Arsenethyl" $(C_4H_5)_3$,As, which, by behaviour precisely similar to that of "Stibethyl," shows itself to be a true epibase, in which we have the metal Arsenic as antistyle. This body is stated to be, like Stibethyl, what might be called, if such a thing really existed, a bistylic base, that is, it is said to combine with two molecules of style to form salts of the form $Æ_3As:St_2$. I believe that the peculiar habit, which is thus interpreted, is to be explained in the same way, in the case of this compound, as in that

* Journ. für prakt. Chem., b. lx. s. 386.

of Stibethyl. And this body, in connectio
cognate compound, $Æ_3As$, which we have
noticed,* seems to me to supply most valu
dence in favour of the theory, which I wo
gest, of the constitution of these salts.

320. I think it probable that some of th
bodies described by Löwig as bases contai
and Ethyl in various proportions,† either
are, or contain, epibases in which Tin occ
antistylic place with metabasic Ethyl. T
"Methstannethyl" $(C_4H_5)_3,Sn_2$, is perha
base, but an epibase containing, as its antis
with a doubled molecule. If so, the sal
it will generate with hydrostyles, will b
form $Æ_3,Sn_2;H:St$. The additional ato
may have been overlooked in the analy
salts. The strong resemblance which it p
H_3N in its properties is very suggestive o
tion, as also is the near affinity which Tin
Antimony in the natural scale of elemen
again, the real epibase may be $Æ_3Sn$, with
Sn. for antistyle. This will be underst
the parallelism of the salts of this mo
those of the compound next to be menti
shall have occasion to speak of "Methsta
again in a future page.

321. Löwig has lately described anot
pound, which, according to his view, wo
base, namely, "Plumbethyl,"‡ having sal

* See § 269, p. 277. † See § 278, p. 2
‡ Journ. für prakt. Chem., b. lx. s. 304.

formula $Æ_3Pb_2$:St. I mentioned this body before,* among the basic metallothyles, but deferred discussing it, because I conceive that it does not belong to their group, but to that of the epibases. Its salts are of a form remarkably different from those supposed to contain Stibethyl or Arsenethyl as their base. The latter contain two molecules of style to one of metal; the former contain two of metal to one of style. Plumbethyl probably corresponds in constitution to "Methstannethyl." Now let us observe that the molecule $Æ_3Pb_2$ has not been isolated. The salts of this base are formed thus:—Iodide of Ethyl is treated with an alloy of Lead and Sodium; from the mutual reaction of these is obtained a mixture of various liquid compounds of Lead with Ethyl, none of which have been isolated. This is treated with Nitrate of Silver; metallic Silver is thus precipitated, and "Nitrate of Plumbethyl" remains in solution, from which the hydrated oxybase—a strong alkali—is obtained by treatment with potassa. This alkali, be it observed, resembles Ammonia in its behaviour, being volatile, and forming white fumes when its vapour is presented to Hydrochloric Acid.

Physiology of Plumbethyl uncertain.

322. Now from the precipitation of metallic Silver out of the Nitrate, by the mixed Lead-ethyl compounds, it is inferred by Löwig, that the base, which takes the place of the Silver in the resulting salt, previously existed in the free condition in the liquid. But this by no means follows as a certainty.

* See § 273, p. 283, and § 280, p. 291.

There are other alternatives of explanation for the phenomenon. There might be in the ethylous liquor a basic substance and an epibasic, both free: the former might displace the Silver, and the latter might adhere to the basic side of the new salt thus formed, and thus our Plumbethyl salt might be constructed. But again, confining our view to a single compound, which may exist in the liquor, and which analogy might lead us to expect, we may yet explain the formation of the new salt without admitting the existence of free basic $Æ_3Pb_2$. Let us suppose that the compound $Æ_3Pb$, analogous to H_3N and $Æ_3Sb$, exists among the mixed "Plumbethyles." Now, from the ready decomposability of the mixed liquid, which may be ignited by strong Nitric Acid, it is obvious that some unstable body or bodies must be present in it. $Æ_3Pb$ may be such a compound; it may be decomposable by Nitrate of Silver. The change, then, that is represented in the following equation is by no means an unlikely one to ensue, and may be that, to which the Plumbethyl salt owes its origin:—

$$(Æ_3,Pb)+4(Ag:O;N,O_5)=Æ_3,Pb;Pb:O;N,O_5+3(Æ:O;N,O_5)$$

Here the Nitrate of Silver [Argenti-Nitrute] is supposed to be decomposed by the destruction of one molecule of $Æ_3Pb$, which supplies four basic molecules to the styles of four molecules of Nitrate. If such be the mode of formation and constitution of these Plumbethyl salts, they contain two atoms of Pb, one of which is probasic and the other antistylic.

323. Again, it is not impossible that in the case of Plumbethyl, as I have suggested for Methstannethyl, the molecule $Æ_3Pb_2$ may be itself epibasic with a doubled metallic molecule for antistyle.

324. If either of the solutions, which I have proposed for the doubt as to the physiology of Plumbethyl, be the true one, we have the geogen Lead added to our list of molecules of antistylic capacity.

325. We find, then, acting as antistyles in epibasic systems the following elements:—Nitrogen, Phosphorus, Antimony, Arsenic, and perhaps Bismuth, Tin, and Lead.

Section IV.

Of the Abnormal Salts of certain Epibases.

Anomalous property of certain epibases.

326. The compounds of the form Thy_3,Mab, which Thy. represents a thyle, and Mab. one of the antibasic metals Sb. or Bi.,* are believed to enter, when acting as bases, the singular property of combining with two atoms of halogen to form salts. The normal salts of these Stibio-thylous systems are of the form $Thy_3,Sb;Thy:St$, which are true salts—epibasistyles, with the molecules represented by Thy_3,Sb, as epibases. The other saline substances which the latter molecule generates are stated to be of the form $Thy_3,Sb:St_2$. This formula is unlike anything which can harmonize with our notions of a single binary salt, that it is quite necessary, if the compounds which it represents a

* Or, also, As.

considered as salts at all,—and such they cer-
ly seem to be,—to suggest for it another shape,
ch may accommodate it to our rules of saline
priety. As it stands, this figure is comparable
h nothing of the salt kind, except the peculiar
es of the compounds of Tin and of Mercury that
respond to the second or higher oxides of these
tals. The anomaly about these new bodies is,
t that they combine with two molecules of simple
logen, for there is no reason why $(Thy)_3Sb$,
uld not act as an antibase, or as a pseudobase,
mbining with a plurality of equivalents of O. or
Cl. However, we might think this rather strange
haviour in an epibase, though it is not an un-
ıal habit among bases. But the difficulty con-
ts in believing that the oxides of the compounds
$hy)_3Sb$, containing two atoms of O., should as-
ne two molecules, or any molecules at all, of the
styles SO_3 and NO_5, and so form true Sulfates
ılfites] and Nitrates [Nitrutes]. For the epi-
les do not generally form definite crystalline
npounds with oxides that are not true binary
ts.

327. The compounds of Tin and of Mercury, to
ich I have here alluded, may be reconciled to
binary theory by the supposition that, in them,
se metals are present in a peculiar molecular
te, having a combining value different from that
ich belongs to them in their other salts.* Un-
this view we bring these compounds within the

* See § 222, p. 209.

general formula of single salts, B:St. The
theory may be brought to bear upon these
compounds of Antimony and of Bismuth.
the method of its application requires to be
what modified in its adaptation to the more
plex molecules with which we have here to
It is obvious that we cannot reduce the
$(Thy)_3Mab:St_2$ to that of a single salt by a
arithmetical division of the basic molecule,
of course is the only modification of the
the constituent particles that we are at liberty
imagine. For we cannot of course alter the
of the several complex thylic molecules; and
uneven coefficient, 3, forbids us to divide the
formula by 2. But these compounds may
double salts, each stylic atom belonging to a
rent basic molecule.

328. Now the habits of both Antimony and
muth afford strong grounds for believing that
metals exist with two distinct combining
The lowest definite oxides of these metals
been the subject of various theories as to
constitution. Some chemists have considered
to be of the formula M_2O_3; others have taken
to be M_2,O_3; and the figures $M:O$, $M_2O_2:O$
$MO_2:O$, have each had their advocates, who
apply them to these as well as to certain
metallic oxides. Laurent at last suggested
two of these formulæ were necessary to expl
the phenomena presented by these puzzling
pounds. He considered that both the formul

ed by Peligot, $M_2O_2:O$, or this modified into $O_2:O$, and another, $M':O$, in which the metals e a different equivalent weight, are necessary to unt for all the changes which these oxides pre-, and to keep them under the bonds of simple gle salts. I am not aware that it has ever yet n proved that such a molecule as M_2O_2, or MO_2, upies the voltapositive side in any saline sys-. I do not conceive, therefore, that we can n much in any case by the adoption of a for-la which involves any such member; and it uld certainly not help us in the least to the un-standing of the compounds here in question. seems to me, however, that Laurent was quite ht in saying that two formulæ are necessary to erpret all the reactions of these oxides and their alogues, and in believing that their metals have o distinct molecular values.* The general ana-y of Antimony to Arsenic would incline us to pect that the oxides of the former correspond to se of the latter. The ratio of the quantities of present in the two principal oxygen-compounds Antimony, namely 5:3, confirms this belief. So at we are justified in representing these two ides as Sb_2O_5 [Stibure] and Sb_2O_3 [Stibire]; d we find this constitution confirmed by the be-viour of these bodies towards the alkaline oxy-es. They both combine with these latter bodies ter the manner of epistyles; and M_2O_5, M_2O_3, e regular epistylic formulæ. These formulæ in-

* See § 222, p. 209.

dicate 129 as the combining value of Antimony; and we represent this proportional quantity by weight of this metal by the symbol Sb. But the same substance, which we are thus warranted in considering as SbO_3, acts towards other re-agents as a true salt: it forms compounds with the stronger epistyles, and interchanges its halogen with the acids by double decomposition. So that we are invited to conclude that it is, under these circumstances, a salt. Rejecting, for the reasons above stated, the formulæ Sb_2O_2:O, and SbO_2:O, as expressions of this fact, we can find no better means of representing it than that offered by the symbol Sb′:O, in which Sb′ represents a metallic molecule (which I would call Stibinum) with one-third of the value, which belongs to Sb (Stibium) in SbO_3, that is to say, 43. Thus the same quantity of matter which is represented by SbO_3, becomes, under the other phase of combining tendency, 3(Sb′O). The dimorphous crystalline properties of this oxide, and the remarkable change of colour which it undergoes from white to yellow on being heated, are noteworthy in connection with its possible mutability of constitution. The same considerations apply to the lowest definite oxide of Bismuth, with this difference, that the reasons for considering that Bi,O_3 is, under any circumstances, the true formula of this oxide, are much less cogent than those which apply to the oxide of Antimony just considered. I am not aware that the compound commonly represented as BiO_3 is ever found acting

as an epistyle. It has, on the contrary, notwithstanding the general analogy of Bismuth to Antimony, all the characters of a true salt, and, as such, should, I consider, be represented as Bi:O or Bi′:O; the quantity of matter thus denoted being equivalent to $\frac{1}{3}(Bi,O_3)$. Under this view the combining value of Bi′ (which, if not allowed to call it Bismuth, I would term Bisminum) will be 71, that usually assigned to Bi [Bismium] being 213.

329. Now we can have no difficulty in admitting that in the epibasic molecules of the form Thy_3Sb the molecule of Antimony is present with the combining value 129, which expresses the ratio of its quantity in these compounds to that of the molecular groups represented by Thy_3. Analogy warrants us in allowing that the metal is here present as a single molecule corresponding to the N in H_3N. And if the corresponding compounds of Bismuth with the Thyles should prove to be epibasic, we shall accept this as another indication of the affinity of this metal to Antimony, and must, with their discoverers, consider these bodies as Thy_3Bi. With respect, however, to the only one of these compounds which has yet been described, namely, "Bismethyl," which is represented as $(C_4H_3)_3,Bi$, the information* which we have at present is not sufficient to decide our view of its constitution. Dr. Breed informs us that it be-

* Löwig, Qu. J. Ch. Soc., vol. 5, p. 71. Breed, Ann. Chem. und Pharm., b. 82, s. 106.

N., three, and only three, molecules of characteristic or metabase. Therefore each of its metabasic molecules contain C. But how the $C_{34}H_{19}O_6$ and $C_{36}H_{21}O_6$ are to be distributed among the three places we cannot tell. Of one point we may be pretty confident, namely, that C_2H_3 does not constitute one of the metabases of Codeine: for, if it did, in all probability one atom of H. would have been metabasic in Morphine, and Mr. How, by his treatment with C_2H_3:I, would have produced the former from the latter, which has the same composition with the difference of C_2H_2 less.

361. One hint we have with respect to the O. We believe we do not yet know any epibase, not containing the molecule NO_4 [Nitrome], which has more than two atoms of O. in one of its metabasic places. We have some instances in which O_2 seems certainly to enter into the construction of a metabase. We may infer therefore that it is not unlikely that O_2 is present in the metabases of these compounds, and that thus the O_6 in them, and in some other epibases, is equally divided between the three metabasic molecules. We may therefore perhaps refine the formulæ of these epibases one step further thus, $C_{34}H_{19}\left\{\begin{matrix}O_2\\O_2\\O_2\end{matrix}\right\},N$, and $C_{36}H_{21}\left\{\begin{matrix}O_2\\O_2\\O_2\end{matrix}\right\}N$. We can proceed no further, without entering on unprofitable speculation. The anatomy of the residual hydrocarbonous molecules may yet be effected by experiment. The action of heat on the com-

pounds of the epibases with H:I, and H:Br, may probably separate one or more of the metabasic molecules with the substitution of Hydrogen in its place. This method of dissection, to which I just now alluded, is suggested by the effect of dry distillation on Hofmann's salts $\left.\begin{matrix} C_{12}H_5 \\ C_4H_5 \\ H \end{matrix}\right\},N;H:Br$, and $\left.\begin{matrix} C_{12}H_5 \\ C_{10}H_{11} \\ C_4H_5 \end{matrix}\right\},N;H:Br$, which under this treatment yield $\left.\begin{matrix} C_{12}H_5 \\ H \\ H \end{matrix}\right\},N+C_4H_5:Br$ and $\left.\begin{matrix} C_{12}H_5 \\ H \\ C_4H_5 \end{matrix}\right\},N+C_{10}H_{11}:Br$.* I am not aware whether the probable practical importance of this reaction has been yet fully recognized by chemists.

Two kinds of bodies yielded by action of Cy, Cl.

362. By a method similar to this treatment of the epibases with the ethy-styles, Cahours and Cloez have recently† given us a hint that may be useful in the comparative anatomy of these compounds. In the course of certain experiments on the action of "Chloride of Cyanogen" [Chlorocyame], Cy,Cl on some of the epibases, these chemists noticed a remarkable difference in behaviour between two groups of these compounds. The kinds in question are the X_3N epibases, containing respectively one and two hydrocarbonous metabases, the dihydronines and monohydronines. The former sort, under the action of this epistyloid pa-

* Phil. Trans. 1850, part i. pp. 101, 118.

† Qu. Journ. Chem. Soc., vol. vii. p. 185. Compt. Rend., t. 38, p. 354.

rahale (Cy,Cl) at a low temperature, yield epibasic parahales, in which compound Cyanogen is substituted for one molecule of Hydrogen, which are not volatile without decomposition, and of the form $\left.\begin{matrix} C_m H_n \\ H \\ Cy \end{matrix}\right\},N$. The latter sort yield analogous compounds, having, that is to say, the form $\left.\begin{matrix} C_m H_n \\ C_{m'} H_{n'} \\ Cy \end{matrix}\right\},N$; but these are volatile with stability.

363. We shall have occasion to notice the latter products in a future page.

Aniline and Nafthalidine are of the Dihydronine kind.

364. Thus, under this treatment Nafthalidine ($C_{20}H_9,N$) ranges itself, as we should have expected from the mode of its formation, along with Aniline, as a dihydronine coordinate with Ethylamine [Monethynine], $\left.\begin{matrix} C_4 H_5 \\ H \\ H \end{matrix}\right\},N$. Nafthalidine therefore is $\left.\begin{matrix} C_{20} H_7 \\ H \\ H \end{matrix}\right\},N$. The characteristic hydrocarbon in this compound ($C_{20}H_7$) is probably basic, notwithstanding its large amount of Carbon. We have already seen* that the molecule $C_{10}H_3$, which occurs in certain derivatives of Nafthaline, the parent of this epibase, is probably basic: $C_{20}H_7$, which we may call "Naftyl," may therefore be formed by the coalescence of three basic molecules, namely, $2(C_{10}H_3)+H$.

Four kinds of synthetical methods.

365. Since much greater progress has been

* See § 265, p. 263.

lew epibases than in
e shall learn more as
bodies generally, from
n from the analytical.
by which new bodies,
e X_3N form, are gene-
l either on the substitu-
for the Hydrogen of pre-
nalogue thereof, or on the
mpounds out of materials
other form, or on both of
conjointly. These methods
four principal heads.

being the simplest of these, is 1. A molecule introduced by double interchange;
e H_3N, or its analogue, with a
olecule to be introduced, in such
double interchange occurs be-
ibstances engaged. It is by this
xample, Benzamide* [Monobenze-
lide [Hydro-camifenile], Ethylani-
fenine], and Triethylamine [Ethy-

ion of Benzamide is a process closely similar to
Iofmann formed his new epibases. There is how-
nce, that the compound $C_{14}H_5O_2Cl$, with which
e treated, is not, like C_4H_5:Br., etc., a salt, the
O_2 not being a base. Is it not possible that the
ss of the interchange in the case of the Thyli-
h require heat and pressure to promote their de-
h the H_3N, is due to the very fact of their being
eir members held together by a force more differ-
which unites the molecules of the epibase, than
nites those of the parahale?

nine] are produced, according to the follow equations:—

(1) $C_{14}H_5,O_2Cl+H_3,N=\underbrace{\left.\begin{matrix}C_{14}H_5O_2\\H_2\end{matrix}\right\}}_{\text{"Benzamide."}},N+H:Cl.$

(2) $C,OCl+\left.\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\},N=\underbrace{\left.\begin{matrix}C_{12}H_5\\H\\CO\end{matrix}\right\}}_{\text{"Carbanilide."}},N+H:Cl.$

(3) $C_4H_5:Br+\left.\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\},N=\underbrace{\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\}}_{\text{"Ethylaniline."}},N+H:Br.$

(4) $3(C_4H_5:Br)+H_3,N=\underbrace{(C_4H_5)_3,N}_{\text{"Triethylamine."}}+3(H:Br).$

or, 2nd, formed by abstracting water, alcohol, etc.

367. A second method is this: the epibase combined with an epistylobase, having for its b Hydrogen or Ethyle, and for its epistyle a m cule containing one more atom of Oxygen than group to be inserted in the X_3N system; and compound thus formed is deprived either of w or of alcohol, the hydrostyle or ethystyle supply one half of such oxybase, the other being for from the displaced Hydrogen of the epibase, t the superfluous Oxygen of the epistyle. Thus generated Oxamide [Xaleminile], Succinam [Succeminile], and Succinimide [Disucceminil

(5) $H_3,N;H:O;C_2,O_3-2(H:O)=\underbrace{\left.\begin{matrix}C_2O_2\\H_2\end{matrix}\right\}}_{\text{"Oxamide."}},N.$

$$H_2N;C_4H_5:O;C_4H_2,O_3-\frac{C_4H_5\uparrow O}{H\downarrow O}=\underbrace{C_4H_2,O_2\Big\}_{H_2}N.}_{\text{"Succinamide."}}$$

$$\frac{H_2N;H\uparrow O;C_4H_2,O_3}{H\downarrow O;C_4H_2,O_3}-4(H:O)=\underbrace{(C_4H_2,O_2)_2\Big\}_{H}N.}_{\text{"Succinimide."}}$$

368. A third method is founded on a re-arrangement of the particles of a nitrogenous compound, a species of internal revolution, by which are generated new molecules, which did not exist in the original substance,—the Nitrogen taking an antistylic or pseudostylic position, which it had not before the change. Thus is produced Cyamelide [Dicaminile] by the spontaneous transformation of cyanic [Cyaric] acid.

3, or by internal rearrangement;

$$3)\ H:O;C_2N,O=\underbrace{(CO)_2\Big\}_{H}N.}_{\text{"Cyamelide."}}$$

369. The fourth may be considered as being compounded of the first and third of the above methods. It comprises those cases in which a re-arrangement of the nitrogenous molecule is accompanied by the introduction into it of new atoms, through a substitution effected by the reaction of another body. To this head may be referred as examples the formation of Aniline [Monofenine], from Nitrobenzol, and of Ethylamine [Monethynine] from cyanate [Cyate] of Ethyl, thus:—

or, 4th, by (3rd) rearrangement and (1st) interchange.

$$0)\ C_{12}H_5NO_4+6H=4(H:O)+\underbrace{C_{12}H_5\Big\}_{H_2}N.}_{\text{"Aniline."}}$$

N., three, and only three, mo
tic or metabase. Therefore
molecules contain C. But
$C_{36}H_{21}O_6$ are to be distril
places we cannot tell. C
pretty confident, namely,
stitute one of the metab
did, in all probability o
been metabasic in Mo
his treatment with C_2
the former from the
composition with the

361. One hint we
believe we do not ye
ing the molecule
than two atoms of
We have some
tainly to enter i
We may infe
that O_2 is pre
pounds, and
other epiba
metabasic
refine the

thus, C

can
pro
d

f Oxygen. Other non-basic molecules may be milarly made to usurp the metabasic place, and enerally, not it appears universally, with the effect f destroying the epibasic character of the system.

373. Of the non-basic atom groups, which can ins be introduced into the X_3N system, the great- st number are partially deoxidized epistyles ana- ogous to those just cited. These always destroy he epibasic quality of the single molecule of the orm X_3N. The compound "Carbamide" [Mo- nocarbaminitrile, or Monocaminile], analogous to "Carbanilide" that would be obtained by substi- uting a single molecule of the simplest of these oxides, C,O, for H., in the simplest of the epibases, H_3N, is not yet known in the separate state. It is however certainly not of itself epibasic. We shall presently meet with it in mixture, or possibly in combination.*

These are usually parahalic oxides.

374. Gerhardt informs us that a compound of this nature, that is to say of epibasic form containing an inserted parahalic oxide, is obtained by treating Aniline with his anhydrous Acetic Acid [Acetire].† There is an obscurity about his statement, for his account of the process does not agree with his symbolic representation of it. He says that the resulting compound is "Acetaniline;" the form of this name would seem to imply that it is an

The case of Gerhardt's Acetaniline.

terms I have derived the name which I have suggested in the text for the nitrogenous parahales into which the several molecules are inserted. (See § 267, p. 272.)

* See § 401, p. 392.

† Qu. Journ. Chem. Soc., vol. v. p. 131.

epibase, but as no actual statement is made to that effect, it was probably not intended, and is very unlikely to be the case. The name however is certainly intended to mean that the compound is Aniline in which one molecule of metabasic Hydrogen is replaced by $C_4H_3O_2$ [Aceteme], or in the unitary notation, one of H′, by $C_2H'_3O$. It is however doubtful whether this is the real result of the reaction: epibases and epistyles, when brought together, usually combine entirely without any substitution or separation of molecules.*

* See note § 290, p. 301. Gerhardt represents this reaction by the following equation:—

$$\left.\begin{matrix}C_2H'_3O\\C_2H'_3O\end{matrix}\right\}O+2N'\left\{\begin{matrix}H'\\H'\\C_6H'_5\end{matrix}\right\}=\left.\begin{matrix}H'\\H'\end{matrix}\right\}O+2N'\left\{\begin{matrix}C_2H'_3O\\H'\\C_6H'_5\end{matrix}\right\},$$

which, being interpreted, would be

$$C_4H_3O_2+\left.\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\},N=H:O+\left\{\begin{matrix}C_{12}H_5\\H\\C_4H_3O_2\end{matrix}\right\},N.$$

According to this equation, water is formed at the same time with the new compound. This however is in direct contradiction of his immediately preceding account of the phenomenon, which is in these words:—"This anhydrous Acetic Acid evolves great heat on mixture with dry Aniline; the mixture solidifies entirely on cooling. If an excess of Aniline is avoided, only one body is produced, crystallizing in beautiful nacreous plates." So that the $\left.\begin{matrix}H'\\H'\end{matrix}\right\}O$ inserted in the equation is a gratuitous interpolation, probably necessitated by the use of the unitarian symbols. And such an elimination of water and formation of a body of the X_2N type would be contrary to all analogy of the reactions between epibases and epistyles. Further, the analysis and chemical behaviour of the Aniline compound are not recorded, so that we are at liberty to adopt the logical inference from M. Gerhardt's own words, namely, that the two bodies combine directly without substitution

. In a later communication* the same inde-
ble chemist has informed us that a body, of
itution analogous to that which he assigns to
' Acetaniline," is produced by the action of his
oride of Othyl,"† $C_2H'_3OCl$, [$C_4H_3O_2Cl$, Uni-
acetime] on Carbonate of Ammonia [Hydro-
carbete]. But he gives of this compound no
iption sufficiently precise to assure us of its
nature. We may however conclude that it
t an epibase.

6. Wurtz‡ however has presented us with a Wurtz's Ethyl-acemides.

aration of any member of either component. I have already
(see § 155, p. 138) that the body which he calls "Anhy-
Acetic Acid" is in all probability really the body that
be so called in the current nomenclature, that is to say
istyle [Acetire] of this acid, and that, therefore, the formula
O_2 is the fair interpretation of his symbols $\left.\begin{matrix} C_2H_3'O \\ C_2H_3'O \end{matrix}\right\}O$.
the reaction may probably be represented thus by ordi-
ymbols:—

$$C_4H_3O_3 + \left.\begin{matrix} H \\ H \\ C_{12}H_5 \end{matrix}\right\},N = \left.\begin{matrix} H \\ H \\ C_{12}H_5 \end{matrix}\right\},N ; C_4H_3 \left\{\begin{matrix} O \\ O \\ O \end{matrix}\right. .$$

re may infer that the new compound is a haloid analogous
body H_3,N_3CO_2 [Nitrini-carbese].

u. Journ. Chem. Soc., vol. vi. p. 195.

ee Qu. Journ. Chem. Soc., vol. vi. p. 226.

'Institut, 1853, August 3, p. 258. I have taken the li-
of translating M. Wurtz's formulæ into the bipolar nota-
He has adopted Gerhardt's theory of the duplicity of water
the aquiform bodies, without adopting Gerhardt's nota-
Thus he endeavours to reconcile the two theories by writing
$\left.\begin{matrix} H \\ H \end{matrix}\right\}O_2$ and Acetic Acid as $\left.\begin{matrix} C_4H_3O_2 \\ H \end{matrix}\right\}O_2$. Dumas does the
n his report on the "Anhydrous Organic Acids." 'Phar-
tical Journal,' 1853, August, p. 71. This compromise,

very instructive experiment illustrative of this point. He informs us that the Cyanate [Cyate] of Ethyl, by treatment with Acetic Acid [Acetiric Acid], at ordinary temperatures, and with anhydrous Acetic Acid [Acetire] in sealed tubes at 180° C, forms two new bodies of the X_3N type, into which, respectively one and two molecules of $C_4H_3O_2$ [Acteme] have entered, taking the position held by equivalent quantities of Hydrogen in H_3N. Thus:

$$C_4H_5{:}O;C_2N,O+H{:}O;C_4H_3,O_3=2(C,O_2)+\left.\begin{matrix}C_4H_5\\C_4H_3O_2\\H\end{matrix}\right\},N.$$

$$C_4H_5{:}O;C_2N,O+2(C_4H_3O_3)=2(C,O_2)+\left.\begin{matrix}C_4H_5\\C_4H_3O_2\\C_4H_3O_2\end{matrix}\right\},N.$$

The resulting bodies, which he calls respectively Ethyl-acemide [Ethaceminile] and Biethyl-acemide [Dinethaceminile], are not epibases, but parahales. In these cases there is, according to this accurate author, no doubt about the evolution of CO_2 [Carbere] from between the combining bodies. The

which, equally with the unitary notation, ignores the evidence of the voltaic pile, as to the side of the salt system to which the molecules of a salt belong, seems to me to make matters more obscure than does the method of the unitarians. Of course the production of the body $\left.\begin{matrix}C_4H_5\\C_4H_3O_2\\C_4H_3O_2\end{matrix}\right\},N$ from the supposed $\left.\begin{matrix}C_4H_3O_2\\C_4H_3O_2\end{matrix}\right\}O$ (or $\left.\begin{matrix}C_2H'_3O\\C_2H'_3O\end{matrix}\right\}O$ (see § 374, p. 130), may seem to argue in favour of the duplicity of the latter body. However, a lower temperature, or a shorter time of treatment, would probably yield the body $\left.\begin{matrix}C_4H_5\\H\\C_4H_3O_2\end{matrix}\right\},N$, analogous to the body which M. Gerhardt perhaps produced. (See § 374, p. 367.)

same phenomenon occurred in a former experiment, by which Wurtz had shown that "Cyanate of Ethyl" [Ethy-cyate], when treated with H:O, forms a neutral body having the composition represented by $\left.\begin{matrix} C_4H_5 \\ H \\ C\ O \end{matrix}\right\},N$* [Ethycaminile], analogous to Carbamide $\left.\begin{matrix} H \\ H \\ C\ O \end{matrix}\right\},N$ [Monocaminile]. It would seem from these reactions that this "Cyanic ether" [Ethy-cyate] probably passes, previously to these reactions, from the saline or polar condition into the X_3N form, becoming $\left.\begin{matrix} C_4H_5 \\ C\ O \\ C\ O \end{matrix}\right\},N$ [Ethydicarinile], a body analogous to Cyamelide, $\left.\begin{matrix} H \\ C\ O \\ C\ O \end{matrix}\right\},N$ [Dicarinile]. When this system is treated with either of these bodies, $H:O$,—$H:O;C_4H_3,O_3$,—or $C_4H_3O_3$, which offer Oxygen to the CO, more or less of this molecule is oxidized, and passes off as C,O_2, its place being taken by Hydrogen, or by $C_4H_3O_2$.

377. The effect however of the introduction of molecules of this particular kind, thus derived from epistyles, into the X_3N system, seems to be constant and decided, as neutralizing the epibasicity of the compound. The extent to which other kinds of non-basic molecules admit of such insertion, and

This last forms also a neutral body.

* This body is isomeric with the double epibase formed by the same chemist, and mentioned below (see § 407, p. 401).

their precise influence when so inserted are not equally certain. Hofmann, incidentally to the account of his construction of his thylous epibases, remarks: "The existence of a series of bases of the formula $C_nH_{n+1}N$, *i.e.* bases containing Formyl, Acetyl, etc. etc., appears to be still doubtful, on account of the electro-negative character of these radicals. By the action of Bromide of Acetyl, C_4H_3Br, upon Ammonia, I have not as yet been able to obtain an alkaloid."*

Products from "Dutch Liquid" possibly exceptions.

378. It, however, has been stated by M. Cloez† that epibases containing the antibasic molecules Formyl (C_2H) and Acetyl (C_4H_3) occupying the metabasic place of H. in H_3N are produced,

* Phil. Trans. 1850, part 1, p. 129, note. My distinguished friend will pardon an observation or two which I must here drop in passing. This passage, in which both the terms "base" and "alkaloid" are applied to the same type of compound, which, besides, I must consider to be neither that of a base nor of an alkaloid, affords a curious illustration of the perversity of chemical language. Our nomenclature is so poor that we are obliged to confound three kinds of bodies under the term "base," not having a separate word for each, yet we have two words available for one of them. It is a misapplication of terms to say that Acetyl (C_4H_3) is electro-negative. No compound of the form $B:C_4H_3$ is known or suspected to exist, for no one can suppose that Olefiant Gas, C_4H_4, is a salt in which one atom of Hydrogen is basic to the rest of the compound. Acetyl doubtless forms part of the volta-negative member of the salts $B:O_2:C_4H_3O_2$ into which it enters, but is never itself voltaically affected at all, so far as we know, either positively or negatively. The fact, which it was intended to express in the sentence just cited, will be conveyed by the substitution of the words "antibasic" and "molecules" for "electro-negative" and "radicals" respectively.

† L'Institut, 1853, June 22, p. 213.

ongst other bodies, by the action of H_3N, ler pressure at 100° C, on the "Dutch Liquid" :Cl;C_4H_3,Cl?]. His account, however, is very tchy; and the statement requires further con- nation. The result of the above reaction is ted to have been solid $H_3N;H:Cl$,* and a uid, which on evaporation, and distillation with alkali yielded the mixture of epibases from ich these two bodies, $\left.\begin{matrix}C_2H\\H\\H\end{matrix}\right\},N$ and $\left.\begin{matrix}C_4H_3\\H\\H\end{matrix}\right\},N$, re obtained. If this is the true constitution of se epibases, they belong to a series of a new and ry remarkable type.

379. Among our modes of generating epibases, e of those included under the fourth of the above ads has been very fertile, namely that which is fected by the deoxidation by a sulfobase of bodies which NO_4 [Nitrome] has been substituted for ydrogen. Most of the bodies, which have thus elded epibases, having been formed from hydro- rbons, contain no more Oxygen than that which elonged to the interpolated NO_4. It is usually

Epibases from deoxidation of substituted NO_4.

* I may here be allowed to remark that if the chlorinated oil btained from Olefiant gas, by action of Chlorine, contains H:Cl, s such, as seems to be the case, the formula which I have above ssigned to it, probably represents its true constitution. We do ot know C_4H_3 as a base, therefore we have no reason to suppose hat it is $\frac{H}{C_4H_2}\Big|\frac{Cl}{Cl}$ (see p. 272). But it is as an antibase that chiefly meets our attention. Perhaps several of these com- ounds of H:Cl with bodies derived from Hydrocarbons are omplex but unstable hydrostyle systems.

this Oxygen only that is removed by the proc
and in the place of the four atoms of Oxygen t
withdrawn, two equivalents of Hydrogen enter
compound, so that the resulting epibase cont
no Oxygen, consisting only of Nitrogen uni
with Hydrogen and Carbon. In this manner,
above instanced, Aniline, $\left(\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\},N\right)$ which m
be taken as the type of the epibases thus produc
is formed from Benzole ($C_{12}H_6$) by the substitut
of H_2N for H., and thus a body analogous
H_3N is formed, containing however the b
hydrocarbon molecule $C_{12}H_5$ substituted for
atom of metabasic Hydrogen.

Such metabasic oxygen groups may be basic,

380. Now we might be inclined to assume, a
the examples which we have noticed, that
other hydrocarbons which, like $C_{12}H_6$, take
metabasic function, are probably of basic ch
But when we find a halogen entering into the c
position of such a molecule, we should hesitat
admitting its basicity. However, Hofmann
Muspratt showed that oxygenous molecules
rived from such hydrocarbons as thus yield
metabases, may be introduced into the epib
system without destroying its power. Thus t
formed "Nitraniline" [Mononitromifenine, or
nomifenine,]* $C_{12}\left\{\begin{matrix}H_4\\NO_4\end{matrix}\right\},H_2,N$, from Dini
benzol, $C_{12}\begin{matrix}H_4\\(NO_4)_2\end{matrix}$, by the same process by wh
Aniline is evolved from Benzol. This Nitrani

* Chemical Society's Memoirs, vol. iii. p. 120.

true epibase, though a weaker one than Ani-
. And since these oxygenous groups, thus en-
ted into the epibasic system, manifestly held,
he compounds from which they were derived, the
ne position that is occupied by the hydrocarbons
ich they have thus imitated in their transition,
may infer that it is likely that they—$C_{12}\left\{\begin{matrix}H_4\\NO_4\end{matrix}\right\}$
d the like—are potentially basic.

381. But in certain other cases we have not ch proof of the basicity of the new metabases, d it may be sometimes rather difficult to suppose at they are endowed with this quality. Thus for stance Anisol ($C_{14}H_8O_2$) is a body obtained by hours by distilling with excess of Ba:O either nisic [Anisuric?] Acid ($H:O;C_{16}H_7,O_5$)* or Sali-late [Salisute?] of Methyl ($C_2H_3:O;C_{14}H_5,O_5$). he same eminent authority has shown reasons for lieving that the true constitution of this Anisol is ch, that in it Methyl (C_2H_3) replaces the basic Hy-ogen of "Carbolic [Fenaric?] Acid." This basic ember of the compound is no longer replaceable Potassium, as is the case with the so-called Acid $:O;C_{12}H_5O$, or $\frac{C_{12}H_5\uparrow O}{H\ \downarrow O}$: hence Cahours would fer that Anisol is either $C_2H_3:O;C_{12}H_5,O$, or $\frac{{}_{12}H_5\uparrow O}{{}_2H_3\downarrow O}$, according as we may find that Fenyl $C_{12}H_5$) is basic or antibasic in the compound.† Now this body, when subjected to the same pro-

but not always so, *e.g.* Anisol.

* See note, § 189, p. 170. † See § 263, p. 259.

cess which converts Benzol into Aniline, yields, a first step, on treatment with fuming Nitric [truric] Acid, Nitranisol, which we may suppose be $\frac{C_{12}\left\{\begin{matrix}H_4\\NO_4\end{matrix}\right\}\uparrow O}{C_2H_3\ \ \downarrow O}$; and then this body by tr ment with $H_3N;H:S$ is converted into an epiba "Anisidine," having the composition $C_{14}H_9O_2$ Now the constitution of this body is uncertain; am not aware whether any one has speculated up it. M. Cahours in his original description* of does not consider the matter. It is undoubte a tridactylous body. But we do not know h the three metabasic places are filled. By applyi to it Hofmann's mode of anatomy, we might certain whether it has two, one, or more of th occupied by Hydrogen. This would be a very teresting experiment. However, from the str probability that C_2H_3 was of itself basic in the ginal Anisol, we may infer that it is most likely itself metabasic in the final epibase. Again, i very unlikely that H:O should occupy the m basic post.

Anisidine viewed as a tridactylous epibase,

382. Hence, then, it is probable that the c stitution of this body is $\left.\begin{matrix}C_{12}H_5O_2\\C_2H_3\\H\end{matrix}\right\}N$: it may h ever possibly be $\left.\begin{matrix}C_{14}H_7O_2\\H\\H\end{matrix}\right\}N$. In either case have in a metabasic position a molecule, eit

* Ann. Chimie et de Phys. sér. 3, t. 27, p. 439.

H_5O_2 or $C_{14}H_7O_2$, which we do not know to be, which may possibly be, of basic function.* generation of this epibase from "Anisic Acid" ems to indicate the latter formula; since the mer would imply the fission of the antibasic olecule ($C_{16}H_7$, or $C_{16}H_7O_2$) of the hydrostyle, the process. However, the probability of the mer constitution is enhanced by the production the same chemist of "Phenetidine," an epibase taining C_2H_2 more than Anisidine. This body derived from $C_4H_5{:}O;C_{14}H_5,O_5$ by reactions like Phenetidine. cisely similar to those by which the former epibase is obtained from $C_2H_3{:}O;C_{14}H_5,O_5$. The obability here that the Ethyl is separately metabasic is greater than that for the Methyl in the mer case, since C_4H_4 is less likely than C_2H_2 to merged in another molecule as a simple increment by one step. The argument is therefore cumulative; and Phenetidine being thus most probably $\left.\begin{matrix}C_{14}H_5O_2\\C_4H_5\\H\end{matrix}\right\}N$, the analogous formula is most likely correct for Anisidine.

383. So if the constitution of Anisidine be, as, I think, is most probable, $\left.\begin{matrix}C_{12}H_5O_2\\C_2H_3\\H\end{matrix}\right\}N$, we have here, in the metabasic place, a molecule $C_{12}H_5O_2$, which differs just by C_2 from the parabasic molecule $C_{14}H_5O_2$ of the parahale Benzamide $\left.\begin{matrix}C_{14}H_5O_2\\H_2\end{matrix}\right\},N$. $C_{14}H_5O_2$ probably antibasic

* See § 262, p. 259; and note † to § 391, p. 384.

draws the Hydrogen in the one case, so in other the Oxygen of the oil seizes it. And then secondary combination between the released N gen and the rest of the oil results in the forma of the new epibase.

Furfuramide may be so formed if Furfurol is $C_5H_2O_2$,

394. And this is precisely the conceptio which we shall arrive by assigning to Furfuro simple constitution of the formula $C_5H_2O_2$. thus also bring the formation of Furfuramide accordance with one of our normal processes. may now compare this process with the gener of Triethylamine [Ethynine], and of Benza [Benzeminile].* Furfuramide bears resemb to both of these compounds. Like the one of it is not an epibase but a parahale. Like the it has resulted from the parent substances, removal of three atoms of Hydrogen and th a halogen from between them. We may the pose that it is formed, like Triethylamine, substitution of a new molecule for each a Hydrogen of the H_3N. Under this view th tion is not complicated by the abstraction o from the Furfurol itself, and we might antici once that the resulting compound would be r because the epibasic character would prob destroyed by the substitution of a non-basi cule, C_5H_2O, for each of its three atoms of basic Hydrogen, Furfuramide being, on this $(C_5H_2O)_3,N$.

or if it be $C_{15}H_6O_3$.

395. Again, similarly, this notion may be

* See § 366, p. 369.

ally of basic character themselves. The ques-
n here necessarily arises, What becomes of the
asic system, if we introduce into it in a meta-
ic place a body that is decidedly not of basic
action?

386. This question might be very simply dis- remove the system from the salt class.
ssed with the answer that the body so produced
not an epibase, nor a salt, and that it therefore
ls outside of the subject of these pages, as our
siness herein is with salts and their members,
d we can only give our attention collaterally and
cidentally to bodies which depart from these
pes. But though this answer would be true to
great extent, as we have already seen, the reply
another question which here occurs to us will so
odify our view of some of the compounds thus
tained, that our rule of exclusion cannot be rigidly
plied to them.

387. We shall hereafter, in discussing the con- Are there epibases of form $(X_3N)_n$?
ction of epibases with the probasistyles to which
ey adhere, meet with numerous instances of epi-
sistyles containing two or more molecules of epi-
se of the form B_3,N. In the cases to which I
ude, these latter molecules, when the salt is split
, always separate from each other as individual
mpounds, not cohering to form a double or mul-
le epibase. But we may naturally ask, Are there
epibases of the form $(B_3N)_n$, in which n,—that
to say, two or more,—molecules of the B_3N type,
ve coalesced into one. If we put this inquiry in
still more general form, and ask whether there

Furfurone probably dimerized Furfuramide.

398. However, the main points for us are, whatever be the constitution of "Furfurami whether it be single or double, Furfurine is doubtedly a dimerized nitrogenous molecule, that it is an epibase, which the former body is It seems very probable that Furfurine is forme the duplication of Furfuramide. If so, the l body must be single, and can scarcely have other constitution than $(C_5H_2O)_3,N$, and furine must be $\{(C_5H_2O)_3, N\}_2$. If hov Furfuramide be already a doubled molecule form $(X_3N)_2$, (as according to our last su tion,) we may suppose that the epibasicity compound derived from it is due to some rangement of the metabasic molecules;

§ 299, p. 307, and § 358, p. 356); this experiment wo inform us how many of the metabasic places of this are already occupied by the carbonous molecules. Wu big's Ann. Rep. of Chem. (Eng. Tr.) vol. iv. p. 30 in forming a body analogous to Furfuramide by the experiment of subjecting Furfurol to the action of " mine" and "Ethylamine." According to the view the text, the corresponding bodies that would be exp result in these cases would be $\left.\begin{matrix} C_2H_3 \\ (C_5H_2O)_2 \end{matrix}\right\}N$, and $\begin{matrix} C_4H_5 \\ (C_5H_2 \end{matrix}$ Wurtz considered that the bodies that would be produc compounds were obtained, must, like Furfuramide, co teen atoms of Carbon for each one of Nitrogen, three of H:O being given off. Since this could not happen, were only two metabasic atoms of Hydrogen left in his he concluded and found that no such compound can duced. Perhaps, however, such bodies as those indicat be obtained by a modification of the circumstances of ture, etc.

niline. Hofmann,* however, disproved this
by producing, by the direct action of Cya-
on Aniline, the new epibase Cyaniline, C_2N.
$\}N$, in which Cyanogen, being appended as
junct to Aniline, presents Nitrogen entering
n epibase in a new and distinctly different
on.

. We may call a molecule, which is thus an- on the outside, as it were, to an epibase, it impairing its combining power, an ex-epi- It is the second case of an ex-epipole, an style† being the first.

Such ex-epipolar molecules are "*ex-epibases.*"

. Subsequently, in his "Melaniline," ‡ N_3,—generated by the operation of dry ride of Cyanogen," Cy,Cl [Chlorocyame], on rous Aniline,—the same discoverer gave us isputable instance of another mode in which gen may be disposed in these important com-s. Other examples of this latter arrangement lready known, but none in which the manner struction was so evident as in this compound. obvious, at the first glance," says Hofmann, Melaniline is produced by the fusion of two e atoms, which have lost one equivalent of gen, and have simultaneously assimilated a tional amount of Cyanogen." In short, the ution of this epibase is represented by the for-

Melaniline contains Cy, but is of form $(X_2N)_2$.

* Qu. Journ. Chem. Soc., vol. i. p. 163.

† See § 103, p. 79; and § 190, p. 174.

‡ Qu. Journ. Chem. Soc., vol. i. p. 289.

action of the H_3N. "Hyd
or ? $C_{21}H_9N$?) is formed
oil of bitter almonds.
for believing that the c
$C_{14}H_6O_2$ (II:O; $C_{14}H_5$,
ration of "Hydrobenzar
of this substance with H
separation of water, one
sary. Either three mole
gage with two of the e
doubling of the nitrogen
once and does not remai
the alkali;—or the carb
must be reduced from C_1
reaction;—in this case th
be a single molecule, n
alkali converts it into th
we may just as well as
doubling of a molecule
easier to conceive, nor n
the queries of a powerfu

sations which were just now presented to us. are, firstly, we find probably occupying the meta- ic place a molecule (Cy.) which is not only not ic but actually stylic, and yet the entire com- and is distinctly an epibase,—perhaps as strong epibase as is Aniline itself, since Aniline cannot el it from its salts. Secondly we here have an lable epibase of the form $(X_3N)_2$, that is to say, substance consisting of a plurality of molecules the form X_3N, and retaining the chemical pro- rties of the normal compound B_3N. There are merous bodies which seem to be constructed on is plan. The modes of generating these multiple ibases are the same generally as those for the gle epibases. The substitutions of the parts are dependent of the coalescence of the entire X_3N olecules. Let us consider some examples of this ructure.

Furfurine also a multiple epibase.

391. The formation of "Furfurine" ($C_{30}H_{12}N_2O_6$) scribed by Fownes,* is peculiarly instructive. he neutral oil Furfurol ($C_5H_2O_2$ or $C_{10}H_4O_4$),†

* Phil. Trans., 1845, p. 253; Pharm. Journ., vol. viii. p. 113.

† Furfurol is probably of the aqueous type, either a coupled or conjugated water. If $C_5H_2O_2$ be its composition, it is most ely a coupled water constituted $\frac{C_5H_1O}{H|O}$. But the numbers $_8H_4O_4$ present us with a more promising form, which is inter- ting as indicating that from this compound we may possibly tain either the members of a new stirps of the thyloid family which Fenyle ($C_{12}H_5$) belongs,—to wit, that which, lying next low Fenyle in the order of complexity, must contain the mole- le $C_{10}H_3$,—or those of the isomeric group to which "Pyridine" $_{10}H_5N$) must be referred. It is worthy of notice, that this

under treatment with Ammonia (H_3N;H generates the neutral compound "Furfurami ($C_{15}H_6O_3$,N?), which by the action of Potas converted, without loss or change of constitu into the epibase "Furfurine" ($C_{30}H_{12}O_6N_2$).* molecule of Furfurol was supposed by its di verer, on the grounds of this very combination,

latter formula just exceeds by two atoms of Oxygen the position of the body that would differ from Fenylic Al ($C_{12}H_6O_2$) by C_2H_2 less: and the boiling-point of Furfurol (166° C, according to Stenhouse,) is about where we should for the boiling-point of the possible body, $C_{10}H_4O_2$, of wh is suggestive, *i.e.* 21 degrees C lower than that of Fenyl-Al (187° C).

If then $C_{10}H_4O_4$ correctly represents the quantities elements in Furfurol, the constitution of this oil may be th conjugated water, thus, $H:O;C_{10}H_3,O_3$, with $C_{10}H_3,O_3$ epi that is to say, it may have the construction of an acid, bu little of acid properties, because of the probable basicity of Or again it may be of aldehydic form, thus $H:O;C_{10}H_3$ with $C_{10}H_3O_2$ as its antibase. Or again Furfurol may be cohol of the form $\frac{H}{C_{10}H_3O_2}\}O$, having the molecule $C_{10}H_3$ a hypobase. If so, we have here a group of atoms bear the unknown Fenyloid Alcohol, $\frac{H}{C_{10}H_3}\}O$, a relation ana to that which the "Hyduret of Salicyle" $H:O;C_{14}H_5$ [Hydro-salisate?] perhaps bears to the "Hyduret of Benz $H:O;C_{14}H_5,O$ [Hydro-benzate]. That the molecule C_{10} might be basic may be inferred from the basicity, which, been shown above (see § 382, p. 376; and § 262, p. 259) belong to the homologous group $C_{12}H_5O_2$.

* The epibasic Furfurine is stated by M. Bertagnini formed at once from Furfurol by the action of dry Amm (H_3N) on the oil. Ann. der Chem. und Pharm., vol. lxxx 128; Gerhardt, Traité de Chim. Organique, t. ii. p. 949.

are the triple equivalent weight $C_{15} H_6 O_6$. How-
ver, with the light which we now have with re-
ect to the constitution of the epibases, I think it
ill be admitted that one of the simpler formulæ
hich I have above assigned to it is more likely to
the true one.

392. If we take the ordinary trebled formula for furfurol, we are constrained to suppose that each olecule of the oil itself is deprived of two mole-
les of water from its own substance, besides the xygen which is withdrawn from it by the Hydrogen the H_3N. Thus, according to this view, Furfura-
ide must have the constitution $\left.\begin{matrix} C_{15} H_4 O_3 \\ H_2 \end{matrix}\right\}$,N; and he mode of its formation does not fall under either the general heads, to which we have referred the aboratory methods of forming the nitrogenous pibases and parahales, and in none of which are ore molecules than one, of water, withdrawn from he aquiform generator of the epibase.*

The triple formula of Furfurol improbable.

393. But now, in the reaction between the Fur-
rol and the H_3N, three atoms of Oxygen and hree of Hydrogen are lost, for every equivalent of H_3N concerned. If we suppose then, that as all his Oxygen is taken from the former generant, so l the Hydrogen is derived from the latter, we get very simple and neat conception of the phenome-
on. The first action on the H_3N now seems to e similar to that which is exerted upon it by NO_3 Nitrire]. As the Oxygen of this epistyle with-

The action like that of NO_3 with H_3N.

* See § 366, p, 369.

another of these parahales which result respectively from the substitution of one or of two equivalents of CO for Hydrogen, may enter into the constitution of an epibase, by combination with another nitrogenous molecule of similar form. Either the dormant epibasic attachment of $\left.\begin{matrix}H_2\\CO\end{matrix}\right\}$ N acquires sufficient intensity to manifest itself by combination, when two such molecules have cohered; or the molecule $\left.\begin{matrix}H\\(CO)_2\end{matrix}\right\}$ N has the property of affixing itself as an ep-epibase to the already epibasic H_3N, just as in Cyaniline $C_2N.\left.\begin{matrix}C_{12}H_3\\H_2\end{matrix}\right\}N$, the molecule C_2N is affixed as an epibase to Aniline, whose epibasic energy is sufficient to allow it to attach itself to the probases of salts, even when it is saddled with this parasitic molecule. In the present state of our science we cannot determine which of these is the true form of the constitution of Urea; we can only take hints from certain analogies which may present themselves to us. Urea, at any rate, being an epibase, would take, according to our system of nomenclature, the name Dicarbamibistraune, or Dicamibinaune; the *au* of the terminal syllable denoting the six $(a+u=1+5=6)$ dactylic molecules, the last *n* marking the epibasicity of the system.

Uncertainty of form of other derivatives from H_3N.

402. We may here take notice of some compounds by which, though they do not yield us free double epibases, we are reminded of the composition of Urea. I mean those which are formed by

action of "Phosgene Gas," C,O Cl [Chlorarbeme, or Unichloceme], and of "Chlorosul- Acid," S,O_2Cl [Unichloroxysulfime, or Unisfime], on H_3N. These bodies are probably ,* and if they are salts, they contain double ases; thus:—

$$\left.\begin{matrix} H_3,N \\ H_2 \\ CO \end{matrix}\right\},N\Big\};H:Cl, \text{ and } \left.\begin{matrix} H_3,N \\ H_2 \\ SO_2 \end{matrix}\right\},N\Big\};H:Cl.$$

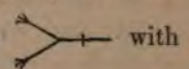
the composition of these epibases is very anaus to that of Urea on the one hand and of nilinet [Cyanodifenybinitraune or Cyadifebie] on the other; of the first, in that CO, and nalogue, SO_2, are substituted for a part of the f H_3N; of the second, in that here, in the led X_3N system, only one out of the six metaplaces is taken by the new nonbasic molecule.

hese substances are considered by some chemists to be but res, not compounds, of $\left.\begin{matrix} H_2 \\ CO \end{matrix}\right\},N$ and of $\left.\begin{matrix} H_2 \\ SO_2 \end{matrix}\right\},N$ with :H:Cl, but since the former molecules cannot be separby mere crystallization or solution from the later, it is prothat they are in combination. It is, however, to be remembthat in subjecting Aniline to treatment with CO Cl, the

olecule $\left.\begin{matrix} C_{12}H_5 \\ H \\ CO \end{matrix}\right\},N$, "Carbanilide," does not combine with

$\left.\begin{matrix} C_{12}H_5 \\ H_2 \end{matrix}\right\},N$:H:Cl, which is formed at the same time, but is ated as a distinct neutral substance (Hofmann, Qu. Journ. . Soc., vol. ii. p. 44). It is somewhat curious, that while the parallel treatment with C_2NCl the double epibase aniline" is formed, no duplication of the nitrogenous molehould ensue in this reaction.

See § 390, p. 381.

Indeed, the formation of these peculiar compounds seems to be precisely analogous to that of the formation of the "Melaniline-hydrochlorate" by treatment of Aniline with C_2N,Cl. There is, however, this difference, that we have not yet isolated the entire epibases of the salts thus formed with $COCl$ and SO_2Cl. In these cases we have the same doubt as to the constitution of the epibase which occurs with respect to Urea, and, we may add, with respect to Furfurine and Amarine. Are the salts of the form  with a double epibase, or are they analogous to the salts of Cyaniline, $C_2N,\left.\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\}N;H:Ha$, which may be diagrammatically denoted by  ? The mode of production of the two compounds which we are just now considering may dispose us to refer them to the latter form; that is, to suppose that in them the molecules $\begin{matrix}H_2\\CO\end{matrix}N$ and $\begin{matrix}H_2\\SO_2\end{matrix}N$ respectively act as ex-epibases. This view may appear the more probable when we remember that these same molecules which here are attached to H_3N are found also on the stylic side of salts in the subsidiary position of ex-epistyles* in the so-called "Carbamates and Sulfamates:"

$$B:O;C,O_2.N\left\{\begin{matrix}H_2\\CO\end{matrix}\right.$$

$$B:O;S,O_2.N\left\{\begin{matrix}H_2\\SO_2\end{matrix}\right.$$

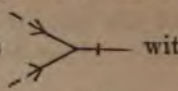
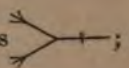
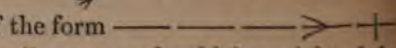
These seem to be a set of molecules which may

* See § 196, p. 180.

h themselves as ex-epibases either to the basic
the stylic side of the salt-system. In the
lophanates," perhaps, we have both the mole-
$\left.\begin{matrix}H_2\\CO\end{matrix}\right\}N$ and $\left.\begin{matrix}H\\CO_2\end{matrix}\right\}N$ (the latter of which is
aps ex-epibasic in Urea) present as ep-epistyles.
composition of these salts is $B{:}O;N_2H_3C_4O_5$,
h is perhaps $B{:}O;C,O_2.N\left\{\begin{matrix}H_2\\CO\end{matrix}\right.N\left\{\begin{matrix}H\\(CO)_2\end{matrix}\right.$. The
e molecule of this system is broken up when
s put in the place of B. by treating one of the
llic salts with an acid; and it is remarkable
now the double ex-epistyle becomes epibasic by
substitution of H. for one of its molecules of
being in fact converted into Urea. However,
respect to the first of our instances of doubled
ases, Hofmann's Melaniline, the subsequent
uction from it, by the same chemist, of "Di-
omelaniline,"* seems to indicate that the two
ecules of the X_3N form, which are united in
former epibase, are symmetrically placed in
salts; for each of them has assumed in the
compound an ep-epibasic molecule of Cyano-
by which the epibasic attachment of the system
rther weakened, but not extinguished. I would
from this double addition that the new very

plex epibase is of the form $\left.\begin{matrix}C_2N.\left.\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\},N\\C_2N.\left.\begin{matrix}C_{12}H_5\\H\\C_2N\end{matrix}\right\},N\end{matrix}\right\}$;

* Qu. Journ. Chem. Soc., vol. i. p. 309.

that is to say, that its salts should be represented as of the type  with two ex-epibases, and those of Melaniline as  ; for by supposing the former to be of the form  with three ex-epibases, we should lose sight of the analogy which the second X_3N molecule bears to the first, an analogy which is certainly closer than its correspondence with either of the molecules of appended C_2N, each of which again are clearly connected with the two X_3N molecules respectively by the same attachment.

Anilo-Urea and Carbamide-Carbanilide.

403. We have also instances in which our fourth mode of the production of bodies of the X_3N form results in the formation of a doubled epibase, with two molecules of antistylic Nitrogen. This fourth method consists, it will be remembered, in a re-arrangement of the constitution of a compound, accompanied by the introduction of a new molecule or molecules into the system by substitution.* The formation by Chancel† of "Anilo-Urea" ($C_{14}H_8O_2N_2$) is such a case. This body, for which Fenyl-Urea would be a better name [Monofedicamibinaune], is formed from "Nitrobenzamide," $C_{14}\left\{\begin{matrix}H_4\\NO_4\\H_2\end{matrix}\right\}O_2\Big\}N$ [Mono Nomi-benzemi-nile], by the substitution of H_2 for O_4 under the action of $H_3,N;H:S$. Analogy en-

* See § 369, p. 365.

† Comptes Rendus, t. xxvii. p. 293. See note to § 407, p. 404.

les us to assume that in this reaction a new relaon is established among the atoms by the Nitrogen the NO_4 that is broken up, assuming an antistyc position towards the molecules with which it is nnected. This view is the more satisfactory as it hibits to us a relation which we see indicated in her reactions between two of the atoms of Carbon the Benzylic molecule and the rest of its assoate particles. If the antibase $C_{14}H_5$ of Benzoic Benziric] Acid be $C_2.C_{12}H_5$, as we have many reans for believing, that of "Nitrobenzoic" [Nomienziric] Acid will be $C_2.C_{12}\left\{\begin{matrix}H_4\\NO_4\end{matrix}\right\}$. Now let s suppose that the formation of Anilo-Urea deends on the division of the single parahalic molele of "Nitrobenzamide" into two similarly triactylic systems, which at once cohere into a double pibase, thus:—

$$\left.\begin{matrix}C_{12}H_5\\H\\CO\end{matrix}\right\rangle N + \left.\begin{matrix}H\\H\\CO\end{matrix}\right\rangle N, \text{ or } \left.\begin{matrix}C_{12}H_5\\(CO)_2\end{matrix}\right\rangle N + H_3N.$$

Here, then, we have the nuclear antibasic C_2, together with the metastylic O_2, withdrawn as $2(CO)$ rom the benzylous molecule, leaving Fenyle ($C_{12}H_5$) a the metabasic position which we see it so reaily assume in "Aniline." We have not, at present, data on which we can determine with certainty the mode in which these two nitrogenous nolecules are disposed; we may, however, be satisied that $C_{12}H_5$ does occupy a dactylic place in one of them; and the fact, that under treatment with X:O;H,O this compound evolves H_3N, while

"Carbanilate" of Potassium, $K:O;C,O_2.N\left\{\begin{matrix}C_{12}H_5\\H\\CO\end{matrix}\right.$

remains, may incline us to prefer the latter of the above two formulæ. Now there is a very interesting point connected with this substance, which marks very strongly how much depends upon the mode in which the constituent molecules are disposed in substances not only having the same elementary composition, but obviously involving the same secondary groups of atoms. This body, which, like Urea, is a true epibase, is isomeric with another body which had been discovered previously by Hofmann,* but which has no epibasic properties, refusing to combine with acids. To this latter compound Hofmann gives the name Carbamide-Carbanilide. We may record its composition and distinguish it from the isomeric epibase by the term Monofedicamibinaule. It is formed by several processes, for instance, by treating Aniline with Cy,Cl in the presence of water; but it also results from two reactions, both of which are strictly analogous to the transformation of "Cyanate of Ammonia" into Urea: these are—first, the addition of Cyanic Acid [Hydrocyate] to Aniline; second, the treatment of Anilo-cyanic Acid [Feny-cyate] with Ammonine.† These changes are indicated by the following equations:—

* Qu. Journ. Chem. Soc., vol. ii. p. 37.

† Qu. Journ. Chem. Soc., vol. ii. pp. 37, 317. See § 402, p. 405.

$$\left.\begin{matrix}\mathrm{Fn}\\ \mathrm{H_2}\end{matrix}\right\},\mathrm{N}+\mathrm{H{:}O;C_2N,O}=\left.\begin{matrix}\\ \\ \\ \end{matrix}\right\}=\left\{\begin{matrix}\mathrm{Fn}\\ \mathrm{H}\\ \mathrm{CO}\end{matrix}\right\}\mathrm{N}$$

$$\text{or } \mathrm{H_3,N}+\mathrm{Fn{:}O;C_2N,O}=\left.\begin{matrix}\\ \\ \\ \end{matrix}\right\}=\left\{\begin{matrix}\mathrm{H_2}\\ \mathrm{CO}\end{matrix}\right\}\mathrm{N}.$$

om this obvious correspondence in origin, Hof-
nn called this product also "Anilo-Urea," sup-
ing that it was the true representative of Urea
the fenylic stirps; he was naturally much sur-
sed that it exhibited none of the attachments by
ich Urea proper is characterized. And it is
rtainly a most curious fact, that the two sub-
nces, Aniline and Ammonine, exhibiting such
rallelism in their general reactions, should di-
rge at this particular point of behaviour. And
are the more struck by this, when we find that
compound which we were disappointed of ob-
ining where we should have expected it, and
ere, nevertheless, a very similar metamorphosis
tually does occur, is presented by another reac-
n of a totally different kind. The decomposi-
ns of this substance seem to indicate that its
nstitution is truly represented by Hofmann's
rm "Carbamide-Carbanilide." When submitted
the action of heat it decomposes, yielding, on the
e hand, compounds which may be derived from
e hitherto unisolated "Carbamide," $\left.\begin{matrix}\mathrm{H_2}\\ \mathrm{CO}\end{matrix}\right\}\mathrm{N}$,
d, on the other, "Carbanilide," $\left\{\begin{matrix}\mathrm{C_{12}H_5}\\ \mathrm{H}\\ \mathrm{CO}\end{matrix}\right\}\mathrm{N}$ [Hy-
ocamifenile], which remains behind in substan-
l crystalline form. Perhaps, when dealing with

no other elements but C., H. and N., and since from the mode of the formation of these compounds it might be expected that Cyanogen would enter into their composition, we may assume that some of the metabasic places are here taken by C_2N. Again, we have no reason for imagining that any hydrocarbon molecules would be formed in the process to which these bodies owe their origin. We may, therefore, conclude that in both of these compounds all the Hydrogen will take the metabasic places which are open to it, without any association with Carbon. With respect to Melamine, we may further infer that in the formation of this body, which contains no Oxygen, all the Carbon would be at liberty to unite with Nitrogen as C_2N, which also would take metabasic duty. Again, we have here precisely enough Hydrogen to supply metabases to two molecules of Nitrogen, and precisely enough Carbon to produce three of our parabasic or metabasic molecules of C_2N. This leaves us three atoms of Nitrogen for the three antistylic places which are thus required; so that, if "Melamine" be of the $(X_3N)_2$ type at all,—and the simplicity of its composition renders this extremely likely,—it must certainly have such a constitution as either $\left.\begin{matrix}H_3\\C_2N\end{matrix}\right\},N)_3$, or $(C_2N)_3,N.(H_3,N)_2$, or $\left.\begin{matrix}H\\(C_2N)_2\end{matrix}\right\},N.\left.\begin{matrix}H_2\\C_2N\end{matrix}\right\},N.H_2N$. We have not data to guide us to a choice between these formulæ. We are not certain in this case that there is any other isomeric substance of differ-

mation of this body from $H_3,N;H:O;C_2N,O$, with the conversion of $H:O;C_2N,O$ into $\left.\begin{matrix}H\\(CO)_2\end{matrix}\right\}N$ "Cyamelide."

405. If we suppose the epibase of the former epibasistyle to remain unchanged during the metamorphosis of the hydrostyle, which would equally undergo transformation if the epibase were not present, we shall view the production of Urea as consisting in the re-arrangement of the atoms of $H:O;C_2N,O$, and in the transference of the new molecule from the position of an acid to that of an ex-epibase. Its $(CO)_2$ due to rearrangement by method 3.

406. Further, let us observe that the effect of the action of $K:O;H,O$ solution on "Carbamide-Carbanilide" is the evolution of H_3N, and of $\left.\begin{matrix}C_{12}H_5\\H_2\end{matrix}\right\}N$. And let us remember that this same reagent converts neutral "Furfuramide" and "Hydrobenzamide" into the epibases "Furfurine" and "Amarine." It will not then seem improbable that a part of the effect of the potash in these latter cases is the formation of H_3N where it did not exist before, this H_3N not being evolved, because it is retained by the other molecule, which is formed by its side, and which with it forms in each case a new epibase. If so, the constitutions of Furfuramine and of "Amarine" would certainly be represented respectively as $(C_{10}H_3O_2)_3,N.H_3N$, and $(C_{14}H_5)_3,N.H_3N$; while in the corresponding neutral bodies, the nonbasic metapoles would be divided between the two nitrogenous molecules. Potash produces Aniline from Carbamide-Carbanilide.

its relation to Melam.

424. The formula of Liebig for Melam may be expanded into $\left\{(C_2N)_3,N\right\}_2,(H_3N)_3$. If this be correct, the neutrality of this substance may be owing to the too great preponderance of C_2N in the compound; it would contain two molecules of Melamine, less one of H_3N.

Melamine is of type (X,N), and is a *Ternosane.*

425. Ammeline differs from Melamine, from which it seems to be formed by the action of acids or of alkalies under heat, in containing Oxygen. The system has lost one atom of Hydrogen and one of Nitrogen and has taken up two of Oxygen in this transformation. It is probable that this interchange has been effected by two metabasic molecules having suffered substitution, viz. one of H. and one of C_2N, each being replaced by CO, two molecules of which are supplied with C. by the fission of the C_2 of the displaced Cyanogen. We have already seen that CO may replace metabasic H., and that in so doing it impairs the epibasic energy of the compound into which it enters. This just accords with the feeble epibasicity of "Ammeline," which we may attribute to the substitution of C,O for the one molecule of H. lost by the Melamine.* We may then suppose that the components

* The epibasic quality is still further weakened in "Ammelide," which seems to be formed from Ammeline by a continuation of the same process of substitution. If we accept the formula proposed by Kopp for this compound (*op. cit.* p. 310), we shall find that while it represents Ammelide as quite symmetrical with the bodies from which it is derived, it accounts very simply for its indifference, $C_6H_4O_4N_4=(CO)_3,N.\left.\begin{matrix}H\\CO\\C_2N\end{matrix}\right\}N.H_3N$. The four

8. The "Ureas" of Wurtz, which contain re- Wurtz's Ureas, and bodies isomeric with them.
tively one and two equivalents of Ethyl and of
hyl substituted for the Hydrogen of common
rea," and which are formed by the automa-
transformation of compounds of the forms
N;Thy:O;Cy,O and $\left.\begin{matrix}H_2\\Thy\end{matrix}\right\}$,N;Thy:O;Cy,O,
n to be true epibases; and for each of these
e seems to be an isomeric substance produced
other reactions, and devoid of epibasic attach-
nt.* The former bodies, together with Chancel's
enyl-Urea," afford valuable confirmations of the
trine that the thyloid hypobases, at least the
pler members of those series, do not impair the
liar properties of the epibases into which they
r, but that, functionally as well as systemati-
y, they replace Hydrogen.

09. Here again, however, the introduction of Modifying influence of Fenyle.
enyle" ($C_{12}H_5$=Fn) into the system, modifies
ome degree the result of the transformation.
mann informs us† that his Anilo-cyanic Acid,
O;C_2N,O [Cyate of Fenyle], when treated
H_3N, generates not epibasic "Anilo-Urea,"
neutral "Carbamide-Carbanilide." Here we
ld have supposed that if this "Anilo-Urea" be
$\left.\begin{matrix}\\)_2\end{matrix}\right\}$,N.$H_3$N, it would have been formed at
by the transformation of Fn:O;C_2N,O into
$\left.\begin{matrix}\\)_2\end{matrix}\right\}$N, and by its transposition with respect to

Qu. Journ. Chem. Soc., vol. iii. p. 91. Gmelin's 'Hand-
' Watts's Eng. Trans., vol. vii. p. 376. See § 376, p. 371.
Qu. Journ. Chem. Soc., vol. ii. p. 316. See § 403, p. 400.

than three atoms of N. There are none perhaps of these which we can with any probability imagine to be molecules of the $(X_3N)_n$ form, n representing a number higher than three; though we may find, as our knowledge extends, that instances of such structure are not wanting. When the number of atoms involved in the composition of a substance is large, the problem of determining its constitution becomes proportionally complicated, and the greater is the amount of positive information which we require for our aid before we can venture to resort to speculation for its solution.

Uncertainty as to higher types instanced in Caffeine.

427. We may illustrate this by a glance at two substances, which derive some interest from the important functions which they have assumed in the domestic economy of Christendom. It has been shown by Stenhouse,* and confirmed by Nicholson,† that "Caffeine," the essential epibase of the three stimulating infusions of Arabia, of China, and of Paraguay, contains four equivalents of Nitrogen, having the composition $C_{16}H_{10}O_4N_4$; and Glasson‡ proved that "Theobromine," the corresponding constituent of the Mexican beverage, was of similar construction, $C_{14}H_8O_4N_4$, differing, in fact, by C_2H_2 from the former substance, which it resembles in chemical as well as in physiological properties. Now Caffeine, when treated with Chlorine, yields, amongst other products, C_2N,Cl and the salt

* Transactions of Chem. Soc., vol. i. pp. 215, 237.

† *Ibid.*, vol. iii. p. 324.

‡ Ann. Chem. und Pharm., b. lxi. s. 335.

411. Here again it is interesting to find an epi- Flavine
mide, isomeric with "Carbanilide," but with an undoubtedly doubled molecule. This is the Flavine of Chancel and Laurent,*—

$$C_{26}H_{12}O_2N_2 = \left(\begin{matrix} C_{12}H_5 \\ H \\ CO \end{matrix}\right\}, N\right)$$

412. This compound, however, is not formed analogous to Dimethyl-Urea.
from "Carbanilide" as "Furfurine" is formed from "Furfuramide," but bears the same kind of relation to that body which the "Anilo-Urea" of Chancel bears to Hofmann's "Carbamide-Carbanilide," being the result of a totally different process. "Flavine" is obtained by the action of $H_2,N;H:S$ on "Binitrobenzofenone," $C_{26}H_8N_2O_{10}$ $=C_{12}H_5;O;C_{14}\left\{\begin{matrix} H_3 \\ (NO_4)_2 \end{matrix}\right\}, O$ [Binomibenzate of Fenyle?],† into which four atoms of Hydrogen are thus introduced in exchange for eight of Oxygen withdrawn. It is clear that this body is analogous to Wurtz's Dimethyl-Urea, being a Urea in which two molecules of Fenyle are substituted for two of Hydrogen, and might be called Difeny-Dicamibinaune, or for convenience, Difenyl-Urea. These Ureas seem to indicate that after the introduction of CO, in the place of one molecule of X., into the X_3N system, the doubling of the entire nitrogenous molecule is necessary for en-

rather, antilogous, to the double and single epistyles, or "Anhydrous Acids," of Gerhardt; in the latter the carbonous molecule is antibasic, in these it is parabasic.

* L'Institut, 1848, p. 95. † See note to § 188, p. 169.

which it adheres in epibasistyles. For a long time Hydrogen was the only molecule known to act as a probase; the hydrostyles the only known probasistyles. And assuredly Hydrogen is the most perfect and commonest of the probases, acting that part towards nearly all the epibases,—perhaps to all those yet known,—except those which contain Mercury* as a metabase and those which contain Antimony and Arsenic as antistyles, with thylic metabases. We may, therefore, in naming such epibasistyles as have Hydrogen for their probase, omit the syllable which would represent that element in the compound word, provided that it be understood that Hydrogen is always the probase whenever no syllable intervenes between the term for the epibase and the stylic part of the name. This is in precise accordance with the rule before laid down, that when Oxygen is the prostyle of an epistylobase, that element need not be mentioned in the current name of the compound.† Thus when, in the name of a di-plectohale, no syllable is interposed between the term for the epibase and that for the epistyle, it must be understood that H:O lies between them as the endohale of the system; the *t* in the final syllable will sufficiently indicate that the compound is a salt, and not a haloid.‡ Thus, we may call $H_3,N;H:Cl$ Hydronino-chlorate; $Æ_3,N;H:Br$, Ethynino-bromade; $H_3,N;H:O;SO_3$, Hydronin-sulfite. Again, we may conveniently apply the term "pro-hydro-

Prohydrostyles.

* See § 346, p. 345 *et seq.* † See § 120, p. 197-199.

‡ See note to § 290, p. 301.

tyle" to any hydrostyle that is considered with reference to the epibases with which, as probasistyle, it may combine.

Various epibases with metallic probases.

429. But we have gradually become acquainted with a number of complex salts in which H_3,N and other epibases are attached to probasistyles having other molecules than Hydrogen for their bases. We have already, in discussing the metabasic part of the salt system, observed that the mercurious molecules Hg_3N, and Hg'_3N, are annexed as epibases to the probasic molecules of metal, Hg and Hg'.

H_3N the most remarkable of these.

430. The compounds of this kind that were first known to us, and which, from their number, are most interesting, are those in which H_3,N is thus annexed to metallic probases. Copper, Silver, Nickel, and Platinum are instances of metals whose salts assume Ammonine very readily. This definite tendency of certain metallic salts to take up H_3,N is shown chiefly in two forms of action, to wit, firstly in the ease with which some of them which are not soluble in water are dissolved in a solution of $H_3,N;H:O$; and secondly, in the absorption of dry H_3N gas by certain of them when in the solid state. These two modes of combination are both exerted by numerous salts of Copper. Copper, indeed, has a greater tendency than any other metal to play the part of a probase: and the mode in which it behaves is very instructive, showing that the force by which a body takes this place in composition is one quite apart from, and additional to, its basicity. Just as among the autostyles the strong-

Cupreous compounds of it.

est have not the greatest tendency to assume
styles, so among the metabases it is only
weaker ones that have the power of strengthen
their position by attaching to themselves their
culiar adjuncts. This probasic force is, no do
stimulated by the induction of the stylobasic
tachment, for the bases have of themselves, w
free, no power to unite with the epibases;
they only acquire it, as the halogens acquire t
faculty of taking adjuncts, by composition
their voltaic antithets. Yet that this is a pec
force, distinct from the stylobasic, is shown by
fact that metallic copper, when aided by the opp
attachment of atmospheric Oxygen for the Hy
gen of water, dissolves in Ammonia-water, t
thus a position which it can only attain by e
ling and supplanting the basic H. of H:O.
Cu. cannot effect this by virtue of its basic en
For Cu. is a very weak base, though its oxide
acts as a very strong prostylobase towards epist
This fact is proved by the insolubility of the
in Hydrochloric Acid, notwithstanding the
ness with which its oxide displaces water from
weak complex acids having O. for their char

* This fact, which I have already mentioned (see
§ 173, p. 155), that the prostylobasicity of a salt towa
styles does not depend upon the basicity of the base, ha
ditional interest when viewed in connection with this ot
that we now encounter, that the probasistylic attachme
salt for epibases does not arise from the stylic energy of i
negative member, but from a peculiar force resident in t
which also is independent of its basicity.

e. When we remember this, the ready solu-
ty of metallic copper in Ammonia-water must
ke us as a very remarkable and significant
nomenon. Copper is almost the only metal
ich, being insoluble in H:O, yet is taken up by
, N;H:O, though the oxides of many are so-
le in this liquid. Copper, in fact, is a very
rgetic probase, and, as are also several other
tals, is stronger in this respect than Hydrogen;
we must consider all those metals whose salts,
t being soluble in potassa solution, are dissolved
Ammonia-water, without the formation of double
ts, as being more potent probases than Hy-
gen.*

* A metallic salt may be soluble in Ammonia-water under
e different conditions. It may owe this solubility to either
the antibasicity of the metal, and the consequent action of the
le as an epistyle to the oxybase $H_3,N;H:O$; (2) the tendency
he metallostyle to form a double salt with the salt of $H_3,N;H$,
ing the same style; or (3) the probasicity of the metal en-
ng it to attach H_3N to its salts.

We have reason to believe that the first cause accounts for the
ppearance of the precipitated oxide of Zinc when H_3N is
ed in excess to a solution of ZnCl. For K:O solution
takes up this oxide, in such a manner that we conclude that
resulting liquid contains K:O;ZnO, and in the case of
N,H:O we may infer that the soluble Zincate $H_3N;H:O;Zn,O$
rmed.

The second kind of combination ensues in the case of Magne-
n salts. We know that when H_3N is added to Mg:Cl solu-
, one half of the Mg. gives its Cl. to an equivalent of $H_3N;H$,
ile the other half remains unprecipitated in the stable and so-
le compound $\frac{H_3,N;H}{(Mg}\Big]\frac{Cl}{Cl)_2}$. For we can form the same

How do metals attach to themselves epibases?

431. It becomes, then, important that we ascertain under what forms of composition epibases are

double salt by mixing the two chlorides, and we do not know that Mg. has either any antibasic or any probasic tendency.

The resistance, by the way, which this double salt and the analogous compounds of Mn. and Fe. salts offer to decomposition by $H_3,N;H:O$, is a remarkable proof that there is a peculiar attachment exerted in the formation of double salts. Either these bases are held in their place in such compounds by a new force by which they are not bound in their simple salts, or their basic power is enhanced by the collateral induction of the other single salt to which they are coupled. For $H_3,N;H$ is certainly, under ordinary circumstances, a stronger base than either of these three metals when in single salts, and, by virtue of this superiority, compels the first half of their quantity, in their single salts, to exchange their style for the weaker Oxygen of the Ammonia; and then the new $H_3N;H$ salt, by its own tendency to form double salts, arrests the action, and combines with the other half. Yet, on the other hand,—and this illustrates the same point from the other side,—Fe., when boiled with $H_3,N;H:Cl$, will act as if it were a stronger base than $H_3,N;H$ towards one-half of that compound, expelling gaseous H_3,N and H., and taking its place, with the immediate formation of the double chloride. A considerable basic energy is necessary to expel even H. from its place, without the presentation of a fresh halogen to the nascent gas; and more potent still must that force be, which will enable another base unconditionally to supplant the H., when its basic energy is exalted by the addition of the H_3,N. Yet this force, as exerted against one part of the $H_3,N;H$, can only be supplied to the Fe. in this case by the suicidal induction of the other part of the complex base. One might almost be tempted to suppose that the real constitution of the salt here decomposed is $\left.\begin{matrix}H'_3,N';H'\\H'_3,N',H'\end{matrix}\right\}Cl'_2$, and that one of the basic molecules was more easily replaced than the other; but I suppose that even the Unitarians will not suggest the duplicating scheme in this instance.

But to return. The third form of combination by which a metallic salt is soluble in Ammonia-water is obviously that which

med by the metals: this inquiry will lead us a further towards our general synthesis of the of the complex base.

erted by that liquid upon CuO or AgO; and we are warded in writing the result of, for instance, the last case of solu-, as $H_3,N;Ag:O$, because we know that Silver, in almost all alts, has the faculty of attaching to itself H_3N, and we do know that its oxide acts as an epistyle towards any prostylo-s. Again, the behaviour of copper turnings with $H_3,N;H:O$ tion may be well contrasted with that of iron filings towards $N;H:Cl$ solution. It may be stated that in the latter case Iron at first expels the H. and H_3,N from the salt, and that he former action the Copper expels the H. but retains the N, which it requires for the satisfaction of its probasic dispo-n. Several metals may occupy each or either of these posi-s in salts. Nickel offers a beautiful instance of this diversity ombining tendency. The colours which most members of the ily of metals to which Nickel belongs confer upon their com-nds, render these in many cases very interesting. This is the in a conspicuous degree with Nickel itself, which, by its beha-r in this respect, illustrates a remarkable fact, namely, that als which determine the colour of the compounds into which enter, almost always show themselves when they act as an-es, by tints different from those which characterize them n present as bases. This is finely exemplified in certain of Ammonine compounds of this metal. Thus $Ni:O;SO_3$ ab-s gaseous H_3N, and generates a salt which with water forms ne solution, or the original salt [Nickel-sulfite] dissolves in $N;H:O$ water with a blue colour. This solution yields blue tals, which have, probably, the following formula:—

$$\frac{(H_3N)_2;Ni\uparrow O;SO_3}{(H\downarrow O)_2}$$

$Ni:O;S,O_2$, mixed with $H_3,N;H:O,SO_2$, yields a green so-on, from which green crystals are obtained, with the formula

$$\frac{H_3,N;H\uparrow O;SO_3}{Ni\,|\,O;SO_3}$$
$$(H\downarrow O)_6$$

Case of one equivalent of metal with one of H_3N.

432. The simplest case of this mode of complication of salts is that in which a single atom of

The former of these two compounds is supposed by some authorities to be of the structure represented thus :—

$$\begin{array}{l} H_3N;H \\ \hline H_3N;H \end{array} \Big| \begin{array}{l} O;Ni,O \\ \hline O;SO_2 \end{array}$$

that is to say, as a double salt, containing two equivalents of basic $H_3N;H$, one of which is united to Ni,O as an epibase. The same chemists assume, that when NiO is dissolved in $H_3,N;H:O$ water, a salt containing Nickel as an antibase is obtained, that is to say, that the resulting compound is not $H_3,N;Ni:O$, but $H_3,N;H:O;Ni;O$. But since Ni:O does not dissolve in K:O solution, nor form any stable compound with K:O, and is not known in any other case to act as an epistyle, while Nickel has strong probasic properties towards H_3N, we may be quite satisfied that in each of these two cases the former is the true, and the latter an erroneous plan of the constitution of the compound, as respects the side on which, voltaically, the metal is disposed. Here, then, we have Nickel in two states, and, as respects H_3N, firstly, as a probase, giving a blue colour, and secondly, as an antibase in a double salt, conferring on the compound almost exactly the same green colour which belongs to its pure hydrated sulfate [sulfite]. But does Nickel ever act as an antibase, and so take the third position in an Ammonine compound? and if so, what colour does it determine? It is certainly not an antibase with Oxygen, but when combined with Cyanogen it does in all probability assume this function. We have every reason to believe that in this respect it follows Iron and Cobalt, with which it is so closely allied, and both of which form very decided and energetic epistyles with Cyanogen. But the epistyle of Nickel is much weaker in its attachment for prostylobases, especially for H.Cy, and therefore Ni.Cy [Cyanicklare] is easily recovered from compounds with prostylobasic cyanides; and we are not acquainted with any definite H:Cy;NiCy [Cyanicklaric Acid]. As respects union with its appropriate hydrogen-prostylobase (H:Cy), it bears the same relation to the cyanides of Iron and of Cobalt that CO_2 bears to SO_3 in its behaviour towards H:O; the former separates at once from the simple acid, the latter

asic metal takes up a single equivalent of the
ibase H_3N, generating compounds of the form

ings to it persistently. But the adhesion of Ni,Cy to the alka-
id cyanides is such, that it forms with them compounds which
nly the stronger acids can decompose. Thus the attachment of
C. for the style of Acetic [Acetiric] Acid, is not sufficient to de-
ach that metal from the compound of its cyanide [cyate] with
Ni:Cy. Further, that the metal Ni. is present in the last-men-
tioned complex salt in a very different state from that in which
it exists in its ordinary salts as a base, is evident from the fact
hat, though these, and among them Ni:Cy itself, are readily de-
composed by $H_2N;H:S$, with separation of Ni:S, this compound
[Cyanicklate of Potassium] is not affected by that vehicle of S.,
so irresistible to nearly all metals when they are in the basic
state.

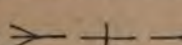
As I have said, then, all analogy would lead us to believe
that the compound of NiCy with, for instance, $H_3N;H:Cy$, is
truly of the form $H_3,N;H:Cy;Ni,Cy$, and not of the form
$\frac{H_3,N;H\uparrow Cy}{Ni\downarrow Cy}$. The compounds of Ni:Cy with the alkaloid cya-
nides seem, in fact, to lie at the extreme of a series of double salts,
at the point where the second member of the coupled compound
has slipped, as it were, over the end of the first member into the
position of a true epistyle (see § 166, p. 145). And we are con-
firmed in the conclusion that the Nickel is truly antibasic in this
case, by the colour of the compound. This salt, when crystallized
with water, has a clear yellow colour, without the least tinge of
green, but with an approach to orange sometimes (the first pro-
bably depending on the amount of water in the crystals, which
seem to occur in two different forms). Now we have seen that
Nickel, when in the position of a base in a crystalline salt, coupled
with water, has in every instance a green or a blue colour, green
when the metal is autobasic, blue, more or less inclining to purple,
when probasic. Indeed the Ni:Cy itself (and it is truly a salt,
though capable of acting as an epistyle), when united with water,
$\left(\frac{H\uparrow O}{Ni\downarrow Cy}\right)$, has the greenish tint usually called apple-green. And

$H_3,N;B:Ha$. Salts of this description will be presented in diagram form, thus,  w

this change from green to yellow which it exhibits in the for tion of its so-called double cyanides [the Cyanicklates], is cisely parallel to the similar mutation of the colour from g to yellow which is exhibited by Iron on its transference f the position of a base, as in $\frac{Fe \uparrow Cl}{(H \downarrow O)_4}$, to that of an antiba $\left.\begin{matrix} K \uparrow Cy \\ K \downarrow Cy \end{matrix}\right\}$;Fe,Cy.

Now we may witness this change of colour in a very beau and instructive reaction. By dissolving $\frac{Ni \uparrow Cy}{H \downarrow O}$ in $H_2N;H$ water, a solution is produced having a blue-purple or amethy colour, the most superb that can be imagined. If to this solu H:Cy is slowly added, the purple colour is gradually ex guished, a neutral tint is obtained, and this gradually gives p to a clear yellow. Now it is somewhat remarkable, that in change from blue-purple to yellow, the liquid never passes thr the phase of green, which not only might be expected from relative positions of these colours in the chromatic scale, which belongs of special right to Nickel whenever it is pres an autobase, either in single salts or in polyhales of which the colouring agent. We might infer from these phenom that Ni. is neither present as an autobase at the commence or at the end of the action, or during any intermediate pa the change. The fact is, that the solute,* or substance diss in the original purple liquor, is in all probability a salt of form $(H_3,N)_a;Ni:Cy$; and at the end of the process the y solution contains the salt $H_3,N;H:Cy;Ni,Cy$. The H which we have added, has in truth been interposed between H_3N and the Ni.; and this metal has passed from the pos of a probase to that of an antibase. And hence the change o lour. The Hydrogen has expelled the Nickel from its plac probase, not by its own superior right to that position,– Nickel can supplant it in that same function, as it does w

* By solute I mean "substance in solution."

le is simple, or  when the
s complicated with an epistyle having, for

dissolved in $H_3N;H:O$ water,—but in virtue of the
njoyed by Ni:Cy, though not by Ni:O, of acting as an

ery strange that a salt so magnificent in beauty and so cu-
many points of its physiology and reactions as this, which,
bsence of any other name for it, I must be allowed to
visionally, Cyade of Hydroninonickel, or Hydronino-
ade, should have escaped description. In the only book
I find any notice of the action of $H_3N;H:O$ water
(Gmelin's 'Handbook of Chemistry,' Watts's Eng. Tr.
p. 498), I find it stated that "hydrated Cyanide of
issolves quickly in caustic Ammonia, forming a yellowish-
lution, containing Cyanide of Nickel and Ammonium,
late of Ammonia." I cannot think that the experiment
h this statement was founded was made with pure mate-
l on a well-washed precipitate of Nickel-Cyanide. I have
e solution a score of times, for the purpose of preparing
which I have mentioned, and which presented itself to
first time I tried the experiment of treating Ni:Cy
$_3$,N, and I have invariably obtained the same result,
the amethystine solution which I have above described.
is gorgeous purple liquid the salt may be obtained in fine
of two different forms. By the slow evaporation of the H_3,N
old solution, it is produced in prismatic needles; the cool-
hot saturated solution yields it in flat plates. In either case
tals are of the same beautiful deep amethyst colour, and
ent so long as they are covered by the solution from which
deposited: but on exposure to the air, or on being placed
, they become opaque (probably from the loss of a cer-
ntity of H_3,N), and assume a delicate lilac-blue or French
t. I have not had an opportunity of completing its ana-
I have satisfied myself, however, that its composition is
Ni:Cy, but I have not ascertained the number of equiva-
H_3N which it contains; when this point has been deter-
a numeral particle may be prefixed to the member "Hy-

instance, three dactyles. In the latter example, it will be observed, we have developed a form of perfect symmetry about a mesial axis; the shape assumed by the diagram may remind us rudely of a pair of limbs of some vertebrate animal. To one or other of these forms all the salts of the so-called "Ammonium" [Hydronine-Hydrogen] belong. There are many instances of it among metallic salts, such being included under the general term hydronipes, more precisely one-hydronipes.* Thus we have

$H_3,N;Al:Cl$† [Hydronin-Alumi-chlorade].
$H_3,N;Zn:O;SO_3$ [Hydronino Zinci sulfite].
$H_3,N;Cd:I$ [Hydronino Cadm-iodade].
$H_3,N;Cu':Cl$ [Hydronino Cuprini chlorade].
$H_3,N;Ag:O;SO_3$ [Hydronin-Argyri-sulfite].

dronine" in the name I have proposed for the compound. A more lovely and inviting salt cannot be found by any one for practice in analysis. It is a very hard and stable compound, and might, I should think, be useful as a pigment or dye.

Thus Nickel enters into the construction of salts containing Ammonine in the three different positions of Antibase, Autobase, and Probase, conferring on the compound in the first case a yellow, in the second a green, in the third a blue or purple colour.

* See § 339, p. 339. I take the numeral prefix in these cases from the English language, not from the Greek or Latin, because epibases are neither basoid nor styloid.

† This compound, according to the usual theory, which assumes the equivalent weight of Aluminum to be 13·7, and its oxide to be Al_2O_3, is written $3(H_3N)\,Al_2:Cl_3$. I consider that this, and all similar formulæ for compounds of Aluminum, denote really three equivalents of the compounds themselves, and

present the combining value of Aluminum as $\frac{3}{2}$ times more than is due to it; so that I take the proper number for this metal to be $13{\cdot}7 \times \frac{3}{2} = 9{\cdot}13$. My reason for this is that I consider it in the very highest degree unlikely to be fact and illogical in theory to suppose that among a host of elements which all, with one exception, enter or are believed to enter, into combination sometimes in single equivalents, there should be a single species which never occurs in composition as a single molecule, but always in twin atoms; and these always united with a plurality of atoms of another element. Besides, there is no such eccentricity of deportment in the salts of Aluminum as to lead us to imagine that they differ in constitution from those of all other bases. It is true that this metal is not a powerful base, that it seems to act the part of an Antibase in certain compounds, and that it does in fact approach the true antibases in the scheme of natural affinity. But this fact is not indicated in the least degree by the sesquiform notation. I believe that this singular departure from the path of analogy is provoked by the resemblance in function of the Oxide of Aluminum to the so-called sesquioxides of Iron, of Manganese, and of Chromium. I am inclined to consider that these three metals and some others (see § 222, p. 209) are of a twofold nature, entering into combination under two molecular constitutions, having in fact two equivalent values. The metals here instanced form two sets of salts, in one of which they imitate the habits of Magnesium, while in the other they follow Aluminum. Under this view, the Magnesoid salts of these three metals should be written $Fe{:}Ha_3$, $Mn{:}Ha_3$, $Cr{:}Ha_3$, as usual, and the Aluminoid salts as $Fe'{:}Ha_3$, $Mn'{:}Ha_3$, $Cr'Ha_3$; their combining values in the former compounds being respectively 28, 27·6, 26·7, and in the latter, 18·7, 18·4, 17·8. It is the perfect analogy of these latter compounds to true salts in ordinary chemical behaviour, that invites us to consider them as binary compounds; but with respect to their constitution, as in other cases, for final judgment we should refer to the voltaic pile. I would call such elements as seem to have two different combining values, "ditimious," from the Greek δις, doubly, τιμη, value. So I would say that metals which in their second state of higher salification are united with 1½ times as much halogen as they take in their first condition,

are in the latter case in the "univalent" state, in the former, "sesquivalent." And of those metals which in their higher series of salts satisfy twice as much halogen as in their first salts, I would say that they are, in their second salts, in the "bivalent" state.

Admitting that in the case of each of these metals the second series of compounds are true binary salts, there are of course two other modes of explaining or of expressing this fact. Either we may suppose that the ultimate or true value of these metals is that which they have in their state of higher salification, and that, as happens with Carbon in the zoögenous compounds, they are polymerized or dimerized in their lower condition; or we may imagine that the halogens which are united with them suffer such an exaltation of their molecular complexity and chemical value in the higher series of salts. The fact that this duplicity of constitution is peculiar to the compounds of only a few metals would lead us to conclude that the change occurs in the metallic member, not in the halogenic part of the salts. Another fact which may lead us to conclude that this phenomenon is due to an affection of the metal, and which may be a ground for inferring that the metal has suffered polymerization when present in the lower salts, and not fission when in the higher salts, is, that under ordinary circumstances, the higher salts of each of these ditimious metals are the most stable. Under this view we may suppose that as complex molecules, consisting of different elements, are generally more easily decomposed than simpler groups, so complex molecules of the same elements may tend to pass into simpler aggregations. Thus we may say the complex metallic molecule ($Fe'\frac{3}{2}$) (=Fe. of our usual notation) has a constant tendency to resolve itself, under favourable conditions, into $\frac{3}{2}(Fe')$, Fe' being the basic molecule of $Fe':Cl=\frac{1}{3}(Fe_2Cl_3)$. But on the other hand, this would almost oblige us to suppose that we have not yet obtained a binary compound of a simple atom of iron with a single atom of halogen; but that Fe_2Cl_3 is $3(fe_4Cl)$, and that FeCl is fe_6Cl,—fe representing the unit of iron with a value $=\frac{Fe}{6}=\frac{28}{6}=4{\cdot}7$. And of course no reason can be assigned why the simplification of the polymerized molecule should be arrested at fe_4.

$H_3,N,Hg{:}Cl$ [Hydronin Hermi chlorade].*
$H_3,N;Hg'{:}I$ [Hydronin Hermin iodade].*

* The word Hermes, the accepted mythological synonym of Mercury, will provide us with a very useful name for the metal which has been called after the volatile god, especially for use in composition, wherein the clumsy compound Hydrargyrum is in little accordance with the subtile mobility either of the messenger of Olympus or of his metallic namesake. It is curious, and a pity, that a word so useful from its brevity, and formerly so current among chemists that even the practice of their science should have been called the Hermetic Art, has fallen altogether into oblivion. According to the usual form of metallic terminology, we may very aptly use the word "Hermium" to represent Mercury, and may derive compound terms from this synonym. Now Mercury, like Iron and certain other metals mentioned in the last note (see note to p. 435), as well as Copper, Cobalt, Tin, and probably Platinum and Iridium (see notes, pp. 439, 459) seems to exist in two conditions, in each of which it acts as a true base, to be in fact ditimious. It differs from Iron and its congeners, but resembles Copper in this, that in the second series of compounds which it forms, and which seem in some cases at least to be true binary salts, it is present in half, not two-thirds, of the proportion by weight in which it enters into the series with the smaller proportion of halogen, so that in its second state it is not sesquivalent, but bivalent. Those compounds of Mercury which contain 200 parts by weight for each chemical unit of halogen, seem, from their close analogy to the salts of Silver, to be true salts. This is confirmed by the formation of a definite Carbonate [Carbete], and of a crystalline Nitrate [Nitrute] of Mercury in this condition. Of the other series of compounds, in which this metal is present in the proportion of only 100 parts, by weight, for each halogen-unit, we are informed by Faraday ('Electrical Researches,' 691, 692, 1341) that the iodide and chloride are not voltalytes; and in this habit they agree with other salt-like bodies that contain a plurality of proportionals of halogen, as is the case generally with the epistyles. And these compounds act the part of true epistyles in combining with the alkaloid

$H_3,N;Pd:O$ [Hydronino-Pallad-oxade].*

salts; so that we are invited to conclude that they are not binary compounds, but contain one equivalent of metal united with two of halogen, so that for example we should write the simplest compound of corrosive sublimate with K:Cl thus, $K:Cl,Hg'Cl_2$. But there are other facts which may incline us to believe that the mercurious compounds of this degree may exist in two states, so that the metal is sometimes present in them as a single proportional of a lower equivalent weight, united with a single molecule of halogen; that, in short, some of these compounds are true salts in which the combining value of this metal is not 200 but 100. The compound which I have represented in the text as $H_3,N;Hg':I$, is an illustration of this. If this compound stood alone we might conclude that it was a haloid (see note to § 290, p. 301) analogous to $H_3,N;C,O_2$, and $H_3,N;Sn,Cl_2$, and to be written $H_3,N;HgI_2$. But some other remarkable compounds of which I shall have to speak below, and the alkaline reaction of the second oxide are the grounds on which I consider that the compounds of this second degree and among them the higher iodide are in one condition true salts, and in another state parahales, or perhaps epistyles. Is it not possible that the dimorphous nature of the second Iodide of Mercury may be connected with this double chemical capability? So that perhaps we may see in the yellow variety $Hg'I$, and in the red, HgI_2. These two kinds of mercurious compounds, if such exist, are quantitatively isomeric with, and probably convertible into, each other. The former will contain Mercury with the equivalent number 100, the latter with the value 200. To the metal, then, in the former sort of these bodies I would apply the term "Herminum," so representing 100 parts of it by weight by the symbol Hg', and expressing always by Hg and by the word Hermium a unit containing 200 parts by weight of the same metal. Thus $HgCl_2$ and $2(Hg'Cl)$ will represent equal quantities of the second Chloride of Mercury under the two states respectively in which I suppose it to exist.

* I believe that the compound $H_3,N;Pd:O$, described by H. Müller (Ann. Chem. und Pharm., b. lxxxvi. s. 346), is the only alkali of the formula $H_3,N;M:O$ that has yet been obtained.

$H_3,N;Pt:O$ [Hydronino-Plat-oxade].*
$H_3,N\ Pt':Cl$ [Hydronino-Platini chlorade].†

By an alkali, be it remembered, we mean such a definite unoxide [oxade] of a definite base as is soluble in water. The formation of such a compound is, except in the cases of certain carbonous oxybases, the highest expression of the definiteness and energy of a base; but few of these complex bases are known to form definite oxides (oxybases), fewer still form alkalies. That Palladium is a strong probase is shown by the fact that the solution of this oxide ($H_3,N;Pd:O$), though it is a stronger alkali than Ammonia, which it will liberate from salts, will not dissolve Cu:O, or Ag:O, which are dissolved by Ammonia-water, because their metallic bases are stronger probases than the Hydrogen which they supplant; that is to say, Cu. and Ag. which are much stronger bases than Pd., are not so much more energetic as probases as to be able to displace Pd. from this probasic position.

* See note to p. 455.

† In the case of Platinum, just as of Mercury, we have the strongest grounds for believing that the metal is ditimious. The compound which I have represented in the text as $H_3,N;Pt':Cl$ is commonly taken to be $(H_3N)_2;Pt,Cl_2$, being called Ammoniobichloride of Platinum. Gerhardt writes it $N_2H_4pt_2(HCl)_2$, calling it Bihydrochlorate of Diplatinamine. I must defer what I have to say on the nature of this compound for a few pages (see footnote to p. 459), just remarking here that there is not the least evidence of the existence of any such body as "Diplatinamine," either as base or as epibase, and that there is no necessity for giving to the particular compound here in question, either so complicated a formula or so prolix a name as that which M. Gerhardt has bestowed on it. We might however suppose, from its arithmetical composition, that $(H_3N)_2:Pt,Cl_2$ is the true formula of this body, and that it is a haloid formed by the union of two equivalents of the epibase H_3N with one of the epistyle $PtCl_2$. $PtCl_2$ is undoubtedly an epistyle, and, as such, forms $K:Cl;Pt,Cl_2$ [Kali-chlo-platete]. But certain modes of formation of the compound cited in the text seem to indicate, I conceive, that in it, at least in certain states, the metal and the Chlorine (though present in the same weight-ratio) are no longer

$H_3'N;Ir:Cl$ [Hydronin-Iridi-chlorade].

$H_3,N;Ir':Cl$ [Hydronin-Iridini-chlorade*].

The *Ammonium* Theory erroneous.

433. To the bases of salts thus containing a single molecule of H_3N as an adjunct, names have been given compounded of the name of the metallic base involved and of Ammonium, the term bestowed on the basic member, $H_3,N;H:$, of Ammonia. Thus we meet with the words Cuprammonium, Argentammonium, Platinammonium. Now if this form of appellation had been invented only to indicate that the salts contained complex bases of this particular type, and had never been taken

in the same relation to each other which they have in $PtCl_2$, but that the metal is here truly basic and probasic, not antibasic, and that it has undergone a process of fission, and is now in the bivalent condition. I conclude that this body is a true salt, and that in it the metal has not the combining value 98·7, but 49·35. I shall have to show, in the sequel, that this theory gives us the simplest view of a large number of compounds, preferring it for brevity to M. Gerhardt's word Platinicum, containing this metal. I would use the word Platinum as a root for the derivation of the names of these compounds, applying to this metal, when in its ordinary state of composition, the shorter term "Platum." I consider that M. Gerhardt is quite correct in his view of the ditimious nature of this metal; but he seems to have added to this truth some other notions, for which there is no foundation in nature, and which involve us in a puzzling labyrinth of almost undisentangleable formulæ.

* This salt is that which is described by Skoblikoff (Annalen der Chem. und Pharm., b. lxxxiv. s. 276) as $IrClN_2H_6,Cl$. I conceive that in the formation of it and of its analogues, the metal has undergone a fission (see note, p. 464). I have placed this salt here as a single salt instead of representing it as a double compound, which analogy would seem to indicate that it is, that the advocates of the H_4N theory may have the benefit of a full test of salts having bases of their hypothetical form.

mean anything else, there could be no objection such terms. But the word Ammonium and its ompounds owe their origin, I conceive, to three alse conceptions, all of which they tend to perpe- uate, not only successively in the minds of all resh students, but permanently in the chemical reeds of all the adepts who use them. Therefore I do not think the words should be continued in currency, unless they are readopted on a basis of a new understanding of their signification. The errors out of which I suppose these words to have sprung are these:—The first is the notion that the complex base $H_3,N;H$ is a self-existent, probably isolable body, which should be written H_4N, or NH_4, just as the equally unknown and improbable compound S,O_4 is substituted for the known complex, but inseparable molecule $O;SO_3$. The second is, that this complex base resembles or is analogous to "a metal." The third error is the belief that there is a peculiar definiteness and stability about the salts having bases of the form $H_3,N;B$.

No "*body*" of this type known.

434. To the first and last of these fancies the bases in question owe their one-worded names; to the second, these names owe their termination in *um*. Now not only do we not know any such body as H_4N, but all analogy is prophesying against the probability of any base of the form H_3BN, or we might even say, more generally, of the form B_4N, being isolated.* The only separable molecules

* Perhaps we may go further, and say that it seems unlikely

with which we are acquainted that, as constituents of these bases, make any approach in complexity to these hypothetical bases themselves, are the epibases of the form B_3N. We know, as has been shown, a very considerable number of actual bodies of this latter constitution. We know also several bases (there are others, yet to be instanced, besides hydrogen and these metals) which, as probases, after, but only after, they have combined with a stylo take to themselves these adjuncts. But we do not yet know a single instance of any complete separable base, or compound of any kind, containing one of these epibases united to a fourth atom of base.

As styles with epistyles, so bases with epibases seem not isolable.

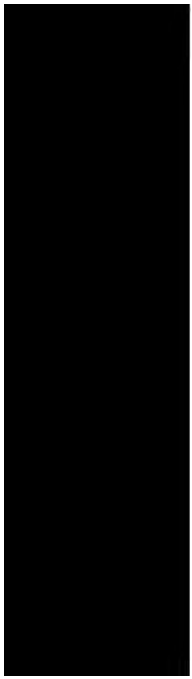
435. Now here we cannot fail to be struck with the remarkable uniformity of the law of construction that prevails in the two members of salts. In the case of the epistyle, we have seen* that though we know hundreds of bodies of this denomination, we have not a single instance of a free stylic body formed by the union of one of these adjuncts to the volta-negative molecule, to which, when this

that there are any free bases of the form B_4Ast where Ast represents any antistyle or nuclear body occupying the position held by N. in H_3N. The only bodies yet announced, so far as I am aware, which seem to be of this construction are, that one of Lowig's Tin-ethyl bases, which he calls Methstannethyl, and to which he gives the formula $(C_4H_5)_2Sn_2$, and his Plumbethyl $(C_4H_5)_3Pt_2$. But neither of these bases have been prepared in a pure condition, and their substantive existence and constitution are doubtful, though their salts are definite. I have already stated the probability that each of these either is, or contains an epibase. (See pp. 319 and 322.)

atter is already in composition, it attaches itself. This correspondence appears to me so beautiful and so worthy to be kept in mind, that even if there were no danger of seeming to indicate a theory in contradiction to the fact, I think it should not be lost sight of in our nomenclature. But the terms Ammonium, Cuprammonium, etc., not only exclude this fact from our view, but substitute for it the misleading semblance of another supposed uniformity which has no place in the reality of nature. There can be no doubt that the regular separability of so many of these epipoles of both sides, their ready adherence to their appropriate propoles when the latter are already united to their sympoles, and their absolute inability to combine with these same bodies when free, are facts that depend upon some simple law. And I think that we have reason for concluding that this is connected with an induction of new and opposite energies upon the simple halopoles by their union with each other in the formation of the salt. I am disposed, further, to consider that having, *à priori*, so much reason for not giving special names, as of isolable bodies, to molecular systems which do not exist, we should not, unless compelled by the *à posteriori* temptation of great convenience and of escape from inconvenience, apply one-worded terms to the complex bases of this form.

$H_3, N; H$ has not a metal's functions.

436. Next it must be remarked that the general comparison so constantly made of the functions of the group of molecules $H_3, N; H$ to those of "a me-



of the solution with Oxyg
resemble those of Fe., M
conditions to absorb Ox
higher proportion of H
nious metals of the Mag
promoted by the prese
This I suppose to be o
H_3N,H as compared wi
of this, either Co_2Cl_3 (
$+Co'O$) is formed, and t
Co or Co′, which enables
to exalt its basic power, n
excess of $H_3N,H;O$, and
ence of the habit of Co. fr
having less probasic powe
under similar circumstan
solution, and consequent
that the further complic
thus : $\frac{H_3,N;H}{\{(H_3,N)_2;Co}\frac{|Cl}{Cl\}_2}$
$+H_3,N;H:O$; the two m
of Chlorine. To the solu
ruple salt, H:Cl is now ad
now evolved, in conformit
the chloride $Co_2:Cl_2$ or Cc
combining value reducing

the basic force may have its strongest hold in another class of bodies,—that of the zoogen compounds. The metals are not typically either basic or antibasic. There is among them one order which is basic, and another that is essentially antibasic; while they contain a third which excels in neither of these, but is marked by the self-sufficient celibacy of its members under ordinary circumstances, and by their strong probasic tendency when once combined. So long, therefore, as a termination in *um* and *ium* is taken to be indicative of metallic function, there is not the least reason for bestowing this feature on our verbal symbols for these basic molecules.

437. Lastly, the complex bases of the form B_3N; B have no ground of peculiar facility of formation, of stability, or of pre-eminent energy, to be considered the most definite of their kind, and to receive on that account the neatest and most precise appellations. For it happens that among the complex salts, formed by the annexation of adjuncts to the base side of simple metallic salts, the basic stems of this particular form are weaker and less stable than such as are generated by the grafting of two or more molecules of H_3,N on the metallic base, while the salts of the former kind are themselves much less numerous, and generally less easily formed than the latter. And among the latter bodies are several the power and stability of whose base-groups is such that their oxides are distinct alkalies, while, as has been remarked

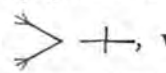
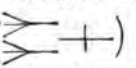
Bases of this type can claim no special pre-eminence.

above,* we as yet know only one definite alka
the form $H_3,N;M:O$, namely, that in which M
represented by Pd.

Nomenclature for salts with repeated epibases.

438. In speaking of those salts which con
more than one molecule of a single epibase
nexed to a single molecule of probase, we
say that such epibase is "repeated" twice, th
etc. We shall thus distinguish them from
salts which contain isolable multiple epibas
And we may call the single salts which contain
peated epibases, generally, monohales with "mu
plex" bases, distinguishing the numbers of th
repetitions by appropriate epithets. Thus s
salts containing two molecules of epibase will
called salts with "doubly complex" or "duple
bases. They may also be called "twinepib
styles." They are precisely analogous to
"twinepistylobases."‡

Their diagrammatical representation.

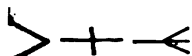
439. Thus, again, diagrammatically we may re
sent, for example, these salts with duplex bases
the diagram  , which will distingu
them from the twinepibasistyles of the other k
() to which I have just alluded.

"*Twinhydronipes*, exemplified.

440. Thus we find a great number of salts hav
the formulæ—

$(H_3,N)_2;M:Ha$, and $(H_3,N)_2;M:Ha;Ab,H$
in which M denotes a metal, Ha a halogen,
an antibase. The latter are of the form w

* See note, pp. 438, 439. † See § 413, p. 408. ‡ See § 102,

may be represented distinctively by the diagram  They would be called generally "Twinhydronipes." Among these we find the place of M in the above formulæ taken by Zn, Cd, Mn, Co′,* Co,† Ni, Cu, Cu′,‡ Sn, Pt,§ Pd,

* Cobalt seems to be not only ditimious, but tritimious, occurring as a probase under three forms :—

(1) With its normal value (29·5) in Claudet's triple salt, described in the next note and in Fremy's Ammonia-cobalt salts [Twinhydronino-cobalt salts] $(H_3,N)_3;Co:Ha$. (Annalen der Chem. und Pharm., b. lxxxiii. s. 236.)

(2) With two-thirds of this value (19·7) analogously to Iron in its sesquichloride (see note, p. 436). The metal in this sesquivalent condition, in which I would represent it as Co′, calling it Cobalticum, seems to be present in Fremy's Luteo-cobaltiac salts (*lib. cit.* p. 289), which, according to him, are of the form $Co_2Ha_3,6NH_3$, but which, if they are true salts (as the occurrence among them of the oxide as a strong alkali seems to assert), must, I conceive be represented by the simpler formula $(NH_3)_2;Co':Ha$ [Twinhydronino-cobalticum salts]. These I take to come under the head of the particular form of salts mentioned here in the text.

(3) With half its normal combining weight (14·75), corresponding to the second condition of Platinum (see note, p. 439); it appears to me to occur in this bivalent condition in Fremy's Oxycobaltiac salts, of which series their discoverer represents the sulphate as $Co_2O_4,2SO_3,5NH_3HO$ (*lib. cit.* p. 248), which I take to be either an octuple salt of the form $\frac{H_3N;H}{(H_3N;Co''\dagger O)_4,SO_3}\dagger\frac{O;SO_3}{(H\dagger O)_3}$, or a quintuple salt, thus $\frac{H_3N;H}{H_3N;Co''}\dagger\frac{O;S_2O_3}{O;S_2O_3}$, or septuple, thus, $\frac{H_3N;H}{(H_3N;Co''\dagger O;H,O)_3}\dagger\frac{O;S_2O_3}{O;S_2O_3}$, $H_3,N)_5;\{\frac{(Co''O)_2;S_2O_3}{(H\dagger O)_3}\}_2$. I would call the metal in this

[illegible] appears in the so-[illegible]

$CuCl_2$, which I would call Cupric-d[illegible]

by Cu. I mean the same metal wi[illegible]

in the second character, which I wo[illegible]

§ The complex but inseparab[illegible] [illegible] among the the tw-hydr[illegible] which it endures change of style, it combines with all the ordinary [illegible] stable even in union with [illegible] least soluble in water. This oxid[illegible] Pt-oxide is commonly called " [illegible] of course it is not base at all, but [illegible] posed by Gerhardt to contain " Di[illegible] imagined of two molecules of H'[illegible] subsequent substitution of an at[illegible] hydrogen. There is not the least [illegible] entered in this compound, or can [illegible] system of either H'_3N' or H_3N. [illegible] of the Ammonium theory a st[illegible] timate consequences. If we once s[illegible] into which Pt., Cu., Ni. or any of [illegible] introduced in the place of H., the[illegible] son why we should suppose that th[illegible] one of these molecules of Hydrogen [illegible] have to do is to adhere strictly to f[illegible] [illegible] basic Hydrogen, but ha[illegible] [illegible] be substituted for metabasic [illegible]

a least reason for believing that the Pt. has anything further to with the H_3N, in the salt here referred to, beyond making of it to strengthen its own position as a base.

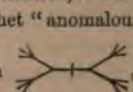
Of course the same statement applies to the compound $H_3N;Pt:O$ (one hydronino-Plat-oxade) which is cited at p. 439, which is commonly called "Reiset's second Platinum ase," being no base at all, and is supposed by Gerhardt to con- a body which he calls an alkali, "Platosammine," NH_2Pt; which, if it existed, would be no alkali, but an epibase. The stance is not a base, but an oxybase; not an alkali like the mer compound, because not soluble in water. These two sub- nces well illustrate, by their relative definiteness and energy action, the absence of any grounds for the belief in the Am- nium form as a typical base-model. $(H_3N)_2;Pt$, is a far more ergetic and more readily constructed base-group than $H_3N;Pt$, hich is obtained by the decomposition of the first. Both are ually innocent of bodily existence, and both are unlikely to arise, are NH_4 and SO_4. These factitious names and formulæ of . Gerhardt seem like the inflictions of the Nemesis of deserted th upon faithless chemists. Given the will-o'-the-wi-p—the mmonium theory—as the guide, M. Gerhardt was quite right nd logical to follow it whither it would take him. But it is me now to go back to fact, before we lose sight of its steady ht for ever.

The chloride [chlorade] corresponding to this latter oxybase, amely $H_3N;Pt:Cl$, is probably only one form of several possi- le isomeric arrangements of the same quantities of the elements oncerned. The same numerical composition belongs to three nown substances. We have, (1) the green modification (Mag- us's compound); (2) the yellow (Reiset's second chloride); 3) the red, Peyrone's salt. It is probable that these are all dif- erent bodies held together by different forces of attachment; this olymorphous condition is probably owing to the double nature of Platinum, which acts both as a base and as an antibase, and on he consequent twofold nature of PtCl, which may be either a alt or a pseudohale acting as an epi-style. Thus these same lements, united in the same proportions, may be grouped as $H_3N;Pt:Cl$ (a single salt with a complex base, having Pt. as its robase), as $H_3,N;Pt,Cl$ (a haloid, containing Pt. as an antibase),

Ir, Ag, and the place of Ha and of Ha;Ab,
occupied, by Cl, Br, I, O, and O;S,O_3..,.O;
..O;NO_5..,.O;Br,O_5..,.O; H,O..,..,. O;C,O
O;CrO_3..* Not every base composed of
of those metals with $(H_3N)_2$ appended to i
yet known to be united with every one of th
styles, simple and complex. But each such ba
known to unite with one or more of the st
here mentioned; some of the former have b
combined with several of the latter; perhaps
those may be united with all these and with oth
not in our present list.†

or as $(H_3N)_2Pt:Cl;Pt,Cl$ (a single, doubly complex salt, ha
Platinum present both as a probase and as an antibase). Not
but the close study of the physiology of these compounds, es
ally with the aid of the voltaic pile, can determine to which of t
each of these formulæ belongs. It seems that the unichl
[chlorade] of Platinum, with two molecules of H_3N, also e
in at least two forms that have different physical properties.
of these undoubtedly is the salt $(H_3N)_2Pt:Cl_2$ another is
bably the haloid $(H_3,N)_2;Pt,Cl.$

* The salt $(H_3N)_2;Pt:O;(Cr,O_3)_2$, described by Mr. B
ton (Qu. J. Chem. Soc., vol. v. p. 220) under the term "Bi
mate of Diplatosamine" [Tw-hydronino-Plati-twichromide],
very interesting compound, from the beautiful symmetry a
constitution, to which its describer applies the very inapprop
epithet "anomalous." It is a perfect example of a salt of

form  , which might be called quadruped, te
tylous, in which, that is to say, the central endohale has
ciated to it on each side two molecules of epipole.

† I must refer the reader for the pairing of these base
styles to Gmelin's 'Handbook of Chemistry,' or to Watts's
glish translation of it.

441. It is important to observe that among the compounds of this group we have several definite soluble oxybases:—$(H_3N)_2;Pd:O$*.,. $(H_3N)_2;Pt:O$†.,.$(H_3N)_2;Co':O$‡.,. and the complex alkalies $\frac{H_3N;H:O}{\{(H_3N)_2Co:O\}_2}$,§ and $\frac{H_3N;Co'_2:O}{\{(H_3N)_2;Co':O\}_2}$. ‖ The two latter, by the preponderance in their structure of the form $(H_3N)_2;Mb:O$, over $H_3N;Mb:O$, claim to range under this head. The actual oxides of the complex bases containing Cu. and Ni. united with H_3N have not yet been isolated, but the occurrence of numerous compounds of these metals of the form $(H_3N)_2;B:Ha$, and the almost total absence of any compounds of these metals of the form $H_3N,B:Ha$, is a ground for supposing that the solutions so easily formed of the oxides of these strong probases in H_3N water, are more likely to contain the bodies $(H_3N)_2;Cu:O$, and $(H_3N)_2;Ni:O$, than compounds with only one equivalent of H_3N.¶ The more typical basicity of the compound $(H_3N)_2Pt:O$, as compared with

This class the most stable and numerous.

* Müller's second alkali, (Ann. Chem. und Pharm., b. lxxxvi. s. 346.)

† Reiset's well-known first alkali, commonly miscalled "Reiset's first base."

‡ Fremy's Oxide of "Luteo-cobaltiac." § Claudet's alkali.

‖ Fremy's Oxide of Roseo-cobaltiac (see p. 82, § 104).

¶ I find no Ni. salt of the latter form described, and the only copper salts of this form that are cited in Gmelin's 'Handbook' are $H_3N;Cu:Cl$, and $H_3N;Cu:O:SO_3$, and they only occur as residues of the decomposition of the normal complex salts containing $(H_3N)_2$. Just so, $H_3N;Pt:O$ is obtained by the decomposition of $(H_3N)_2;Pt:O$, which is the normal oxybase of the salts having Pt. as their archibase.

$H_3N,Pt{:}O$, is remarkable: both these oxybases exist, but only the former is an alkali. The salts containing two molecules of H_3N—the tw-hydronipes—seem on the whole to be the most numerous and stable of those whose complex bases involve epibases of this kind.

Other kinds of salts with complex epibases.

442. Next we have the form $(H_3N)_3M{:}St$. Such salts we should call "Thr-hydronipes." Under this head we find M. represented by Ca, Zn, Cd, Co, Ni,* Cu, Bi(?); Ag, and the style side filled by Cl, I, Br, $O;SO_3$., $.O;N,O_5$.

There are even $(H_3N)_4;Ca{:}Cl$, and $(H_3N)_4;Sr{:}Cl$.†

Then under the forms $(H_3N)_5;(M{:}St)_2$, we have for M. Zn. and Cu., with Br. and O,S,O_3 for St.

So under $(H_3N)_5(M{:}St)_3$ we find Fremy's "Roseo-cobaltiac" alkali, and the corresponding salts, having Co'. for M. and $O.$, $.Cl.$, $.O;SO_3$, and $O;NO_5$ for St.

And under $(H_3N)_5(M{:}St)_4$, I conceive, are to be placed Fremy's Oxycobaltiac salts, having Co". for M.

Again, we have $(H_3N)_4;(M{:}St)_3$, which includes Zn. for M. united with $O;IO_5$ for St., and also

* To this form $(H_3N)_3.M{:}Ha$, belong the definite series of Fremy's "Ammonia-cobalt" salts. A distinct set of salts of similar composition are formed by the metals Cu. and Ni., which are closely connected in affinity with each other and with Co. This seems to be a very stable configuration, inferior only to that of $(H_3N)_2,M{:}St$. I believe no oxybases of this order are yet known, but the readiness with which the corresponding Co.,—Ni.,—and Cu.—salts of other styles are formed indicates a probability that even alkalies may yet be produced of this configuration.

† See note, p. 477.

Fremy's "Fuscobaltiac" salts, having Co'. in the place of M.

We find also $(H_3N)_3;(Cu:Br)_2$, and $(H_3N)_3;(Ag:Cl)_2$.

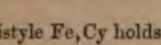
In all these salts we have a greater number of molecules of epibase than of probasistyle. There are also instances of complex salts of this kind, with converse ratios of the quantity of these constituents.

Thus of the form $H_3,N;(M:St)_2$ we have salts having for M. the metals Zn, Cu, Hg', Pt',* and for

* The compound $H_3N(Pt':O;H,O)_2$ [Hydroninobiplatinhydrate] is the hydrated oxybase of the Platinum salts of this form. It is a strong oxybase, but not an alkali. M. Gerhardt, its discoverer, calls it "Platinamine," giving it the formula $N'H'pt_2+2(H'_2O)$, supposing it to contain a body of the form of H'_3N', but having two of the atoms of H. replaced by pt., that is to say, by the metal Platinum in that state in which he considers it to have its combining value halved, and in which he calls it Platinicum. It is a pity that in the excellent compendium of Gerhardt's Platinum salts inserted by the learned translator in the English edition of Gmelin's 'Handbook,' it is said (vol. vi. p. 314) that "Platinamine—$NHpt_2$—is obtained in the form of crystals," etc. This erroneous statement is contradicted by the subtext, but might mislead a student to believe that this imaginary substance had really been produced. Even according to the formula given with the analysis, the substance obtained is not Platinamine, but a compound thereof with water. The crystalline body described is "$NHpt_2+2aq$," which formula, interpreted into common symbols, by halving the combining value of O., becomes $NH_6PtO_4=H_3N(Pt':O;H,O)_2$, the hydrate of *the oxide*, between which and the hydrate of the unknown epibase there is a wide gulf, and a wider between it and the epibase itself. I consider that Gerhardt is quite correct in his view of the condition of the metal in these compounds as respects its equivalent weight, but that he is altogether wrong as to the position which one of

St. the molecules Cl, I, Br, O; HO, O, NO_2. Under its molecules occupies in the salt. For there is not the smallest evidence that the constitution of this body is that which he assigns to it. On the contrary, we have every reason to conclude, from the mode of its formation, that the whole of the metal is truly basic and probasic, and that it has associated to itself the adjunct NH_3, undergoing at the same time fission into two molecules with half combining value. Our reason for supposing that the metal has suffered this change in the compounds of this series, is that they have all the habits of true salts, and that the oxide combines with epistyles, forming complex bodies of such definiteness as belongs in general only to the compounds of these epistyles with true bipolar stylobases. There is, of course, the same kind of ambiguity about the chlorides and other analogous compounds of this series as pertains to those of the other kinds before mentioned (see note to p. 455). Of these, the root compound is Gerhardt's Bihydrochlorate of Platinamine, $N'H'pt_2, 2H'Cl'$. The elements here combined may cohere under two forms, as in the case of the complex salts derived from PtCl.—$PtCl_2$, however, by itself, perhaps cannot exist as a salt, but only as a pseudohale or epistyle: it probably can only pass into the condition of a salt after union with H_3N, which seems to facilitate the fusion of the metallic molecule. The compound thus formed probably exists under two conditions, namely, as $H_3N;PtCl_2$, a haloid, and as $H_3N\left\{\begin{matrix}Pt'Cl\\Pt'Cl\end{matrix}\right.$, a double salt with the divided metal-molecule. I believe it has only been obtained in one form, at least that it has not been recognized in different forms as the result of different modes of production. The behaviour of Gerhardt's compound seems to indicate, in some degree, that, in the form in which he obtains it, it is not a true salt, though the compounds which he derives from it are of this nature. It is evident that the salts obtained from this chloride by double decomposition must be double salts, since they have but one molecule of the epibase H_3N for every two equivalents of Pt':Cl, so that they will retain the form which I have here assigned to the saline chloride. Such salts are exactly analogous or antilogous to the "Ferrocyanides" [Cyaferrates], in which

e form $H_3N(M:St)_3$ we find the metals U., Fe'., d Al'. united with Cl.

e molecule of the epistyle Fe,Cy holds together two particles f prostylobase. The figure of the salts we are here discussing , I suppose,  , that of the Ferrocyanides being  (see § 104, p. 81.).

Amongst the doubled Platinum salts of this kind, one is described which seems to have two different epistyles annexed to the two molecules of the stylobase (Pt′:O); this is Gerhardt's "Nitrate of Platinamine" $N'H'pt_2,N'H'O_3+2(H'_2O)$, which I suppose to be $H_3N\begin{cases} Pt' \mid O;N,O_3 \\ Pt' \mid O;H,O \\ (H \mid O)_2 \end{cases}$.

There seems to be a remarkable tendency among some of the compounds of this metal to assume the form of double salts with different styles in the two members. This is exhibited by the curious series of salts discovered by Gros and by Raewsky, as revised by Gerhardt. The type compound of this series is the body $(H_3N)_2PtCl_2$, which I have already mentioned (p. 439) as probably passing into the state of a binary compound by fission of the metal-molecule, and so becoming $H_3N;Pt':Cl$. I have placed this compound in the list of salts of the form $H_3N;M:Ha$, that the advocates of the "Ammonium" theory may have the fullest benefit of every substance which can be referred to the formula of this type. The same necessity which holds in the case of the chloride with only one equivalent of H_3N for two of Halogen, certainly does not bind us to consider this other chloride as a double salt, because there is here a separate particle of H_3N available to be assigned to each molecule of Pt′Cl. But reasons may be urged for supposing that this chloride is really a double salt $\frac{H_3N;Pt'\dagger Cl}{H_3N,Pt'\dagger Cl}$; those who prefer dimerized molecules when they can get them are entitled to claim this as such, so long as we are unacquainted with simpler compounds in which Pt′. occurs with the halved value.

Mr. Buckton (Qu. J. Chem. Soc. vol. v. p. 216), in describing a series of double salts formed by the chloride [chlorade]

$(H_3N)_2;Pt:Cl$, with the simple chlorides of certain basis metals, mentions some instructive reaction which takes place between this Pt. salt and the chlorides of two other metals, which, like Pt., are ditimious, namely Fe. and Cu. The salt Fe_2Cl_3 ($Fe^{v}:Cl$) does not, like Pb:Cl, or Zn:Cl, form a double salt with the Platinum compound. But when the two salts are brought together, the Iron passes to the lower state of chlorization and the Platinum proceeds to the higher; or, as I suppose, the combining weight of the former metal is raised and that of the latter lowered. The resulting Platinum compound is the salt containing the elements H_3NPtCl_2. Again, with CuCl,—[$Cu':Cl$]—a double salt $\frac{(H_3N)_2;Pt:\uparrow Cl}{Cu^{v}\downarrow Cl}$ is formed; this readily undergoes a change due to the alteration in the state of the Copper, which passes to the state of Cu., with the doubled equivalent, while a part of the Platinum member is represented as the same questionable body which is called the "chloride of Gros's base or Gros's radical." The ready formation of double salts in most of the reactions of these chlorides will, of course, incline many persons to believe that Gros's chloride, as formed in these two cases, is a double salt, and so to be written $\frac{H_3N;Pt'\uparrow Cl}{H_3N;Pt'\downarrow Cl}$, and not $H_3N;Pt'_2Cl$.

But this notion may appear to be further confirmed by the remarkable behaviour of this chloride in forming double salts, in which the same base is repeated in each member with variation of one of the styles, the Chlorine however remaining constant in the other. The construction of these salts was explained by Gros, on the hypothesis that they contained a "radical" or base into which Chlorine entered as a component. Not the slightest reason ever existed for supposing that the Chlorine in these compounds formed part of the volta-positive member of the salts; so that the "radical of Gros" $PtClN_2H_6$ was a pure fiction. How active the fancy of chemists may become in the pursuit of a favourite theory is illustrated by the statement to be found in a valuable manual of our science, that the "radical of Gros" $=PtClN_2H_6$ is entirely analogous in its chemical relations to Ammonium, and is probably, like that body, a compound metal." The only analogy which it has to Ammonium is that of being not a body, but a non-existent fabrication.

Gerhardt has not much improved our conceptions of the constitution of these salts; for though he has so placed the Chlorine as that it is not, in his formulæ, obviously on the wrong side, he has substituted another confusion for that which he has neutralized by the invention of the equally fictitious molecule $N'_2H_4pt_2$, which he calls Diplatinamine.

The former of these two theories of the constitution of the salts of Gros and of Raewsky would only be warranted by either of two experiments. The one of these would be a voltalysis of one of these compounds resulting in the evolution, on the positive side, of a compound containing Chlorine, or of free Chlorine mixed with other products. The other would be the formation, by any method whatever, of a basic molecule having the composition assigned to the hypothetical "radical."

The latter of the two theories cannot be said to rest on any support until one of two compounds has been produced; either the compound $N'_2H'_4pt_2$, which if it existed would be an epibase, or the compound $N'_2H'_4pt_2H$, which would be a base.

Until one or other of these four experiments has eventuated successfully, all analogy entitles us to believe that the whole of the Chlorine in these compounds lies, as in all ordinary salts, on the volta-negative side. It must be borne in mind that there is no analogy between the mode of formation of these salts and the construction of the complex carbon-containing epibases, into which Chlorine has been introduced by substitution for Hydrogen. The question is not, can Chlorine lie on the volta-positive side?—that may be affirmed,—but, have we any reason for supposing that it forms part of the basic side in these compounds? There is but one answer to this question,—a most decided negative. The Chlorine is certainly held in its place in certain of these salts by a peculiarly strong force of attachment, so that while one portion of it is expelled by rival styles, another remains in its seat. But so is the Mg. held in the salt $\frac{H_3N,H:\uparrow Cl}{Mg\downarrow Cl}$; $-H_3NH:O$ cannot dislodge it; but we do not therefore conclude that the Mg. is on the volta-negative side. We are more accustomed to meet with double salts in which one base is persistent, than with such in which one style is so affected; and thus the latter form strikes us as an anomaly, but the two cases are truly parallel.

There seem to be four series of these multiple salts; namely, two double and two quadruple, of each of which one set contains the persistent Chlorine, and one is free from it. Of these the following are examples:—

	Polar formulæ.	Gerhardt's formulæ.
(1)	$\frac{H_3N;Pt'\uparrow Cl}{H_3N;Pt'\downarrow O;NO_5}$	$= N'_2H_4pt_2,N'H'O_3,Cl'H'.$
(2)	$\frac{H_3N;Pt'\uparrow Cl}{H_3N;Pt'\downarrow O;HO}$ $\frac{}{(H_3NPt'\downarrow O;NO_5)_2}$	$= N'_2H'_4pt_2,(N'H'O_3)_2+H'_2O.$ $N_2H_2pt_4,Cl'H'$
(3)	$\frac{H_3N;Pt'\uparrow O;HO}{H_3N;Pt'\downarrow O;NO_5}$	$= N'_2H'_4pt_2,N'H'O_3+H'_2O.$
(4)	$\frac{H_3N,Pt'\uparrow O;HO}{(H_3NPt'\downarrow O;NO_5)_3}$	$= (N'_2H'_4pt_2)_2(N'H'O_3)_2+H'_2O.$

Intermediate between the second and last of these, (1) and (4), seems to be (5) $\frac{H_3N,Pt'\uparrow Cl}{H_3N,Pt'\downarrow O)_3PO_5}$, to which Gerhardt gives the formula $\begin{cases} N'_2H'_4pt_2,PO_4H'_3 \\ N'_2H'_4pt_2,Cl'H' \end{cases}$.

It will be observed that in the formula which I have given for the last of these salts (5), the normal relation between the epistyle P_2O_5 and the oxybase to which it is annexed is preserved, namely, one molecule of the former to three of the latter. If this formula is the true one (and its simplicity is in its favour), it shows that a real fusion of the metal molecule has taken place, one part of it entering into the phosforous system, the other remaining with the Chlorine. One among the above salts (2) seems as if it were formed by the coalescence of the two double salts which stand on each side of it. No oxybase of either of these series is known, but the formation of the coupled carbonate containing CO_2 substituted for NO_5 in (2) is an evidence of the stability and energy of the basic system.

Iridium seems to form a series of double salts analogous to the first of the above instances. The constitution of some of the salts described by Shoblikoff (Annal. der Chem. und Phar., b. lxxxiv. s. 275) is best explained on this hypothesis, of the fission of the metallic molecule and the coupling of the salts themselves. The compound formed by the action of $H:O;NO_5$ on the salt

Finally, we have $H_3,N;(Sr:Br)_4$, a quadrupled salt with a single molecule of adjunct.*

$H_3N;Ir:Cl$, can scarcely be expressed at all as a salt, if it be such, without supposing that the metal is divided. With this assumption this compound and its derivatives are double salts, thus: $\frac{(H_3N);Ir\,|Cl,}{(H_3N);Ir'|O;N,O_5}$, in which Ir′ represents $\frac{99}{2}=49'5$ parts by weight of the metal in reference to 8 of the Oxygen,—this halved metal I would call Iridinum. This salt, it will be observed, resembles the last-mentioned Platinum salts in having different styles in the two members. The salt which I have represented as $H_3N;Ir':Cl$ (p. 440) may also be a double salt $\frac{H_3N;Ir'\,|\,Cl}{H_3N;Ir'|Cl}$: if it be homologous with the nitrate it must be. But I do not think that there is any necessity for considering that the molecules of this salt are in the dimerized condition.

* I conceive that the compounds $H_3N;Si,F_3$,— $H_3N;SnCl_2$, — $H_3N;SbCl_3$, — $H_3N;Au,O_3$., — $(H_3N)_2;Ti,Cl_2$., — $(H_3N)_3;AsF_3$, — $(H_3N)_3;SiCl_3$ — $(H_3N)_4;AsCl_3$., — $(H_3N)_6;Sb,Cl_5$ belong to a different type, namely to the class of haloids of which $H_2N;C,O_2$ — $H_3,N;S,O_3$., — $H_3N;(S,O_2)_2$ are less questionable examples (see note to § 290, p. 301). We have no reason for supposing that these bodies, each formed of an epibase with an epistyle, are salts at all.

Perhaps the bodies $H_3N;PtCl_2$ — $(H_3N)_2;Pt,Cl_2$ — $(H_3N)_2;Ir,Cl_2$ — even $H_3N;Pd,Cl$, in certain states, belong to this class of compounds. It is probable that these compounds of Pt. and of Ir., which are ditinious metals, are not salts when first formed with the bichlorides, which are true epistyles; but that they pass into the state of salts, this passage being accompanied or preceded by that fission of the metal-molecule, which I have supposed to take place as necessary to the conversion of the body into a binary compound. We do not yet know that Palladium is ditimious; but its unichloride [chlorade] acts the part of a true epistyle with alkaloid chlorides. It is possible, therefore, that PdCl is not always a true salt, though it be a binary compound: that it may, in fact, like FeCy, be capable of

Probably some are coupled simpler salts.

443. It is of course possible that many salts of these multiple forms may consist really of two or more salts of simpler kinds $M:St.$, $H_3N;M:St.$, $(H_3N)_2M:St.$, $(H_3N)_3;M:St$ coupled together.

Thus taking Fremy's highly interesting Cobalt salts as illustrations, his Roseo-cobaltiac salts $(H_3,N)_5;(Co':St)_3$ probably consist of three molecules of his Luteo-cobaltiac salts, $(H_3N)_2;Co':St$, from one of which one equivalent of H_3N has been abstracted, thus, $\frac{H_3N;Co'\left\{St}{\{(H_3N)_2Co'\}St\}_2}$ * and his Fusco-cobal-

undergoing a kind of transformation from the one state to the other. This difference of condition may be connected with the two isomeric forms of the compound $H_3N\,PdCl$; the red and the yellow; the red compound which is precipitated on adding H_3N to $PdCl$ may perhaps be a haloid and not a salt; the yellow body formed by dissolving this in $H_3N:HO$, and neutralizing with HCl, is undoubtedly a salt, co-ordinate with the alkali $H_3N;Pd:O$ of Müller (see note, pp. 438, 439).

So, as I have suggested above, the two states of Hg'I, as respects colour, may be connected with a transition from the condition of a salt to that of an epistyle. (See note to § 432, p. 437.) We may conceive how, as may be the case with $PdCl$, a compound may consist only of two atoms, and yet be different in properties from another made up of the same two atoms, if we refer their powers not to the mechanical form of their aggregation, but to the deeper and more vital source, the force which holds the atoms together. Two particles of iron, attracted towards each other, will be in very different states as respects other objects, according as their mutual sympathy is due to magnetic or to electric induction. By a conception based on the relations of force to matter we place isomerism on a much wider field than mere mechanical notions of shape and position of atoms will afford for its explanation.

* It will be observed that according to this formula, both Fremy's Luteo-cobaltiac and Fusco-cobaltiac salts are of the same

In each of these cases there is a very strong probability that the members of the latter pair of groups are really constituted respectively according to the same plans of organization which are found in the former pair; that is to say, that of these plectopoles, which are not autopoles, all the plectostyles are constituted on a common plan, and also all the plectobases on a common plan.

All are "epipolous."

504. Further, again, it appears that there are not here two plans, but one plan of constitution; for that the type of structure is the same for both these kinds of plectopoles. The complex halopoles stylic and basic, both consist of a primary molecule or propole, with one or more secondary molecules or epipoles attached to it; so that, distinguishing such plectopoles as are thus formed, containing an epipolic constituent, by the epithet "epipolous," we may say that all plectopoles, which are not autopoles, seem to be epipolous in constitution. In the greater number of cases the annexation of an epipole to a propole, on either side of the salt-system, greatly increases the natural polic* energy of the member so strengthened. There is a peculiar tendency in certain of these epipoles, of either kind, to attach themselves in couples to their proper propoles. The energy of the halopoles thus formed with two epipoles is usually much exalted, and the salts which they form with their sympoles often remarkably stable.

* "...polic" to mean "belonging to a ..." in the sense of "having

O. have been absorbed and have caused the fission of each molecule of the metal into two, thus:—

$$2\left\{\begin{matrix}(H_3N)_3:Co\uparrow O:NO_5\\(H\downarrow O)_2\end{matrix}\right\}-(H_3,N+2(HO))=\begin{matrix}H_3N:Co''\uparrow O)_2:NO_5\\(H_3N)_2(Co''\uparrow O)_2:NO_5\\H\downarrow O)_2\end{matrix}$$

Among Fremy's salts there are thus three types, namely, those that contain respectively the probasic molcules Co., Co'., and Co''. Of these three kinds we have single salts of Co., and Co'., namely, his salts of Ammonia-cobalt [Thr-hydronino cobalt] and Luteo-cobaltiac [Tw-hydronino cobalticum]. His salts of Roseo-cobaltiac [Fiv-hydronino tricobalticum] and Fuscobaltiac [Four-hydronine tricobalticum] are multiple salts of the Co'. kind, and his salts of Oxycobaltiac [Fiv-hydronino dicobaltinum] are multiple salts of the Co'' kind, of which the single salts are as yet unknown.*

Review of the Hydronipes containing Platinum.

444. It may be well here also to recapitulate the results at which I have sought to arrive with respect to the compounds of Platinum, containing H_3N, since the remarkable probasic powers of this metal give it a peculiar interest and value in

* I hope that the eminent authority whose masterly examination of the Ammoninious-cobalt salts has cleared up the obscurity of their nature, will not, if he should ever see these pages, consider the mode in which I have ventured to handle his salts a very insolent comment on the words with which he concludes his detailed account of them :—"Wollte man in diesem Augenblick schon weiter gehen, und die rationelle Constitution der vierfach-zusammengesetzten Basen zu ermitteln suchen, so wurde man meines Erachtens den experimentalen Weg verlassen, um sich, ohne grossen Nutzen für die Wissenschaft, stets unsicheres Hypothesen hinzugeben."

esent inquiry. Like Cobalt, it has already
ed us with several distinct series of com-
s of this order, among which we already are
inted with one strong alkali, and two insoluble
ses. These salts may be thus represented.

$H_3N,Pt:St.$ Salts of "Reiset's second base" or of Gerhardt's "Platosamine" [or of Hydronino Platum]. Oxybase known: insoluble in water.

$H_3N\left\{\begin{matrix}Pt'\dagger St\\ Pt'\ddagger St'\end{matrix}\right.$ Salts of Gerhardt's "Platinamine" [or of Half Hydronino Platinum or Tw-hydronino Diplatinum]. Oxybase known, insoluble in water. Cannot exist as single salts.

$\begin{matrix}H_3N;Pt'\dagger St\\ H_3N;Pt'\ddagger St'\end{matrix}$ Salts of Gerhardt's "Diplatinamine"] or of Hydronino Platinum]. Include the salts of Gros and Raewsky; perhaps do not exist as single salts. Oxybase unknown.

$\left.\begin{matrix}H_3N\\ H_3N\end{matrix}\right\}Pt:St.$ Salts of "Reiset's first base," or of Gerhardt's "Diplatosamine" [or of Tw-hydronino Platum]. Oxybase known: a strong alkali.

annot imagine anything simpler than the no-
which is here offered of the constitution of
compounds. The only unproved assumption
s made in this scheme is, that the metallic
ule of Pt. admits of fission under the com-
agency of H_3N, and of the halogens, into

2Pt′. This same view is adopted in the theory of these same compounds that has been put forward by M. Gerhardt; though by him conjoined with two other assumptions which are perfectly groundless, and, as seems to me, unless for the general purposes of the unitary scheme, equally useless. The one of these fictions is, that in entering into these compounds the metal is divorced from the styles, with which it is united in ordinary salts; the second, that the metal enters into the system of H_3N, replacing a part of its Hydrogen. I think the general analogy of other salts warrants the belief of the fission of the probasic molecule of the metal. For the rest, the notation which is here presented indicates exactly what from the modes of their formation and decomposition we know to be the case with these salts, and exhibits them as instances of the general results of a beautiful law which governs the formation and the properties of complex salts.

The names for B_3N; B compounds must involve the probase and epibase.

445. I conclude, then, from the facts and considerations which I have adduced, that there is no ground for assuming that any such body as B_4N or as H_4N, of which any one of the atoms of Hydrogen indifferentlymay be replaced by a metallic molecule, exists; and that the basic groups of molecules, of the form B_3N; B, which have given rise or support to the superstition about B_4N, have no such exclusive resemblance to metals or even restrictedly to basic metals as to entitle them to a distinctive metalloid nomenclature. Further, since these bases are but the "baseless fabric of a vision," and not real

bodies, I do not consider that we require single-word-names for them at all, but that their names should express their nature, being formed from the term for their epibase prefixed to that for the probase to which it is attached. Thus the names which I have proposed for them are in accordance with the methods of their actual formation, without implying any ulterior assumption as to their constitution.

$H_3N;H$ cannot replace H in $H_3N;H$.

446. If then there are no grounds for believing in H_4N or in B_4N as a body, still less, *à fortiori*, have we reason for supposing that any of the more complicated bases, containing two or more repeated equivalents of H_3N, are in reality of this hypothetical form, having one or more atoms of the Hydrogen of the fundamental H_4N, substituted in turn by H_4N itself. For if it had not been supposed that H_4N was an actual bodily base which replaces basic Hydrogen in salts, no one would have imagined that just as the Ethyloid hydrocarbon bases replace Hydrogen, both basic and metabasic, so by repetition this same H_4N could replace metabasic H. in H_4N itself. So that if, for instance, the salt $H_3N;Pt:Cl$, does not and cannot be supposed to contain a base $N\left\{\begin{matrix}H\\H\\Pt\\H\end{matrix}\right.$,—that is to say, an Ammonium, $N\left\{\begin{matrix}H\\H\\H\\H\end{matrix}\right.$, in which some one atom, no matter which, of H. is replaced by Pt.,—there can be no room for fancying that the salt $(H_3N)_2;Pt:Cl$

rstly, we know no other instance of a base so strong $H_3N;H$ occupying the metabase place; if such a rm existed, we might expect to meet with salts such shapes as $K_3,N;M:St$, since K. is a close nitation of $H_3,N;H$: but no one expects to find ich a compound.

strong base goes into metabasic position.

448. Secondly, we know no salts thus compounded n which the Pt., Cd., or Ca. of the salts just cited, re replaced by H. If in these three salts the secon- lary molecules $H_3,N;H$ occupied a position at all imilar to that which is occupied by Ethyle C_4H_5,

The H_3N molecules are agglutinated by the probasic power of the metals.

$$\text{r}H_4C_4;H, \text{in } C_4\begin{matrix}H\\H_5\\H\end{matrix}\Big\}N;H:Br \text{ or } C_4H_4,\begin{matrix}H\\H\\H\end{matrix}\Big\}N;H:Br,$$

r which the Hydrocarbon molecules occupy in Hofmann's complex bases, we might expect that st as this salt is formed by treating H_3N with $_4H_5:Br$, so we might form such a salt as

$$_3N;\begin{matrix}H\\H\\H\end{matrix}\Big\}N;H:Br$$ by treating H_3N with H_3N; :Br. From our inability to form any such body this, we may infer that the agglutination of the veral molecules of H_3N in the complex metallic lts which I have cited depend, not upon the sus- ptibility of the H. of H_3N to substitution or an- xation, but on a peculiar power in the metals ich are involved in these compounds, the power ich I have called probasic, and which enables em, when under the induction of a stylic mole- le, to associate to themselves one or more pro- rtionals of this adjunct. Again, if the formula

of one of these salts were $H_3N;\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N;M:Cl$, we should expect that just as we can liberate H_3N or $C_4\left.\begin{matrix}H\\H_5\\H\end{matrix}\right\}N$ from a salt of the form $H_3N;M:Cl$, or $C_4\left.\begin{matrix}H\\H_5\\H\end{matrix}\right\}N;H:Cl$, so we should be able to form such a body as $H_3N,\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N$, by the decomposition of the former system. But we cannot, we know no such body. And this inability is not connected with any general indisposition of tridactylous nitrogenous molecules to cohere; for as we have* already seen, numerous compounds, some of them epibases having the form $(X_3N)_n$, are known where X indicates a variable molecule and n denotes either of the numbers 2 or 3. We have, therefore, no more right to suppose that the second molecule of H_3N is annexed to the H. of the first H_2N, than we have to suppose that a second H_4N is inserted into a first H_4N.

Confusion arising from so treating the epistyles.

449. Thirdly, if these salts having bases of the second and higher degrees of complexity were to have their constitution expounded on this plan, we should, I conceive, be bound to apply the same scheme of theoretical construction to those salts which have styles of the second and higher degrees of complication.† Thus we should have to

* See §§ 391 and 422, pp. 383 and 417. † See § 100, p. 77.

consider the salts

$$Na:O;(Bo,O_3)_2 \text{ as } Na:O;Bo,\begin{cases}O\\O\\O;BoO_3\end{cases}$$

$$K:O;(S,O_3)_2 \text{ as } K:O;S,\begin{cases}O\\O\\O;S,O_3\end{cases}$$

$$K:O;(Cr,O_3)_2 \text{ as } K:O;Cr\begin{cases}O\\O\\O;CrO_3\end{cases}$$

$$K:O;(Si,O_3)_2 \text{ as } K:O;Si\begin{cases}O\\O\\O;SiO_3;\end{cases}$$

for example, as having the second molecule of each epistyle annexed to the oxygen of the first. Some of the silicates [multisilicates] with which mineralogy supplies us would offer admirable opportunities for constructing involved formulæ on this plan; we should be able to annex subadjuncts of SiO_3 to each atom of O., not only of the primary molecule of that compound, but to those of the second, perhaps of the third order also. I do not think we should gain anything in precision from adopting this notion of the construction of these bodies. We should certainly learn nothing from it. All that we know, or have a good reason for believing, of these compounds, is that the molecules of epistyle are annexed to the stylic side of the salt, and of epibase to the basic side. We need not express more than this in our formulæ or in our names, and by expressing this we shall keep a clear conception of a method in the construction of salts, which is as remarkable for its beauty as

for the extent and variety of its application. It is probable that all the forms which I have cited of salts, simple and multiple, having complex bases, may be matched with parallel structures taken from among the so-called basic salts and acid salts having complex styles with similar numerical relations of their epistyles to their prostyle bases. But as my object is to suggest rather than to exhaust the subject, I need not pursue the analogy in this place.

Especially those of the form $Ha;AbHa_n$.

450. I will only add that the same arguments which oppose the assumption that the group of atoms H_3N,H forms a distinct molecule NH_4, exclude, by parity of reasoning, the admission of the hypothesis that the complex styles of the form $Ha;AbHa_n$ are distinct molecules of the form $AbHa_{n+1}$: and this the more forcibly as the number of assumptions which we have to make for this side of the salt system is infinitely increased by the vastly greater variety of compounds for which we have here to account. For if we are to admit SO_4 as a distinct stylic substance, not only must we set up BoO_4, CrO_4, SiO_4, SiF_4, PO_8, Pt,Cl_3, and a host of analogues, but, to account for such compounds as those which I have just cited, we must suppose that several, perhaps all, of these bodies are liable to suffer replacement of a part of their halogen by entire groups of their own molecules. That is to say, we must further assume the existence of such bodies as $Bo\left\{\begin{matrix}O_3\\BoO_4\end{matrix}\right.$, $S\left\{\begin{matrix}O_3\\SO_4\end{matrix}\right.$, $Cr\left\{\begin{matrix}O_3\\CrO_4\end{matrix}\right.$, $Si\left\{\begin{matrix}O_3\\SiO_4\end{matrix}\right.$, etc. And all this

ı, however, we consider that the principle of sity is most marked in the basoid members of bodies, and that it is in these members only we have the important alternative of com- y presented to us, it will be seen that if the fication is founded on the simplicity or com- y of the basoid member of the epipole in the ase, the simplicity or complexity of the basoid bers of the epipole in the other case, must in- e important divisions of the groups.

8. These, then, seem to be the natural group- of the kinds of the two sorts of halopoles.

I. Styles.

Order I. Autostyles. { Family 1. Simple (Halogens). Family 2. Complex.

r II. Prostyl-epistyle. { Tribe 1. Styles having single Antibases. Tribe 2. Styles having complex Antibases.

Order III. Styles containing exepistyles.

II. Bases.

rder 1. { Tribe 1. Simple Bases.
itobases. { Tribe 2. Complex Autobases. { Family 1. Hypobases. Family 2. Synthyles.

der 2. -epibases. { Tribe 1. One Antistyle. { Family 1. Metabases simple. Family 2. Metabases complex.
Tribe 2. Two Antistyles.
Tribe 3. Three Antistyles.

Order 3. Bases containing exepibases.

9. The further subdivisions of the Bases and ıe Styles will be recapitulated in the next cr, in which we shall consider the classifica- of salts in general. To this latter object, be mem[illegible] classification of styles and of wh[illegible] he most part hypothetical, is

the existence of salts, containing complex bases of the form Thy,H_2,N;M:St, in which Thy represents one of the Thylic bases Methyl, Ethyl, or Amyl, and M. represents one of the probasic metals above mentioned. These actions were clearly cases of the attachment of the new epibases to the metallic bases of the oxides in question, with the formation of complex salts such as $\left(\begin{matrix}C_2H_3\\H_2\end{matrix}\right\}N\Big)_n$;Cu:O, etc.

454. Wurtz, again, in a subsequent memoir on his new epibases,* informed us that they, $\begin{matrix}C_2H_3\\H\\H\end{matrix}\Big\}N$ and $\begin{matrix}C_4H_5\\H\\H\end{matrix}\Big\}N$ form with Pt:Cl compounds precisely analogous to certain of the Platinum salts that have H_3N as epibase. Thus he obtained compounds which belong to two different series of salts, and which are not represented so simply by any formulæ as by the following:— Their analogies with H_3N, in their Pt. compounds.

$$\begin{matrix}Me\\H\\H\end{matrix}\Big\}N;Pt:Cl. \qquad \begin{matrix}Æ\\H\\H\end{matrix}\Big\}N;Pt:Cl.\dagger$$

There can be no doubt, I think, that Platinum acts

* Ann. de Chim. et Phys., ser. iii. t. 30, p. 443. Liebig's Ann. Rep. on Chem., Eng. tr. vol. iv. p. 301.

† These two compounds, like the analogous H_3N salts (see note, p. 455), are of uncertain composition; they may be salts of the form $\begin{matrix}Thy\\H\\H\end{matrix}\Big\}N)_2$;Pt:Cl;Pt,Cl, (analogous to that which has been supposed to belong to "Magnus's green compound,") or they may be haloids thus:— $\begin{matrix}Thy\\H\\H\end{matrix}\Big\}N$;Pt,Cl, containing antibasic Pt.

in these compounds as a probase to the carbonous epibases.

$$\left(\begin{matrix}\mathrm{Me}\\ \mathrm{H}\\ \mathrm{H}\end{matrix}\right\}\mathrm{N}\Big)_2;\mathrm{Pt:Cl.}^{*}\qquad \left(\begin{matrix}\text{Æ}\\ \mathrm{H}\\ \mathrm{H}\end{matrix}\right\}\mathrm{N}\Big)_2;\mathrm{Pt:Cl.}^{*}$$

Müller's analogous Palladium compounds.

455. More recently,† Müller has described some very interesting salts produced by the action of the first of these epibases on Chloride of Palladium; both the mode of formation of these compounds and the phenomena which they present are closely similar to the results obtained by the combination of H_3N, with Pd:Cl. These compounds are:—

Müller's formulæ.	*Polar formulæ.*	*Müller's name.*	*Systematic name.*
(1) $N\left\{\begin{matrix}C_4H_5\\ H_2\\ Pd\end{matrix}\right\}Cl.$	$\left.\begin{matrix}C_4H_5\\ H_2\end{matrix}\right\}N;Pd:Cl.$	Chloride of Palladethylamine.	Monethyleno-Palladichloride.
(2) $N\left\{\begin{matrix}C_4H_5\\ C_4H_5N\\ H\\ Pd\end{matrix}\right\}Cl.$	$\left(\begin{matrix}C_4H_5\\ H_2\end{matrix}\right\},N)_2;Pd:Cl.$	Chloride of Palladdiethylamine.	Diethyleno-Palladichloride.
(3) $N\left\{\begin{matrix}C_4H_5N\\ H\\ H\\ Pd\end{matrix}\right\}Cl.$	$\left.\begin{matrix}C_4H_5,H_2N\\ H_2N\end{matrix}\right\};Pd:Cl.$	Chloride of Palladethyldiamine.	Monethyleno-Palladi-chloride.

He also found that Aniline, C_{12},H_5,H_2,N [Monofenine], added to PdCl solution, gives a yellow precipitate, which is probably $C_{12}H_5,H_2,N;Pd:Cl$. Hofmann ‡ had noticed, many years ago, that this

* There is nothing to warrant the assertion of the eminent discoverer of these compounds, that in them Pt. is metabasic, and that they contain epibases of the form $\left(\begin{matrix}\mathrm{Thy}\\ \mathrm{H}\\ \mathrm{H}\end{matrix}\right\}N+\left.\begin{matrix}\mathrm{Thy}\\ \mathrm{H}\\ \mathrm{Pt}\end{matrix}\right\}N\Big)$

The groundlessness of this notion of metabasic Platinum will be best demonstrated by the formation of salts of the form $Thy_3,N;Pt:St$ and $(Thy_2,N)_2;Pt:St$. Such in all probability can be easily generated by the treatment of Pt:Cl with $(C_2H_3)_3N$.

† Ann. Chem. und Pharm., b. lxxxvi. s. 346.

‡ "On the Bases in Coal Naphtha," Phil. Mag. March, 1844.

(1,2,1,1)3, etc. Other C_mH_n— nuclei.
(1,2,1)2. Nuclei containing halogens (O. and perhaps S.).
(1,2,1,2)1. $C_mH_nO_r$— nuclei.

. . . . . .

(1,2)2. Synthyles.
(1,2,2)1. Metallothyles.
(1,2,2,1)1. One molecule of metal with one molecule of thyle.
(1,2,2,1)2. One m. of metal with 2 m. thyle.
(1,2,2,1)3. One m. metal, more than 2 m. thyle.
(1,2,2,1)4. More than one molecule of metal.
(1,2,2)2. Mefitithyles.
. Probas-epibases.
(2)1. Epibases with one antistyle.
(2,1)1. N. as antistyle.
(2,1,1)1. Elementary metabases.
(2,1,1,1)1. Hg. as metabase.
(2,1,1,1)2. Hg.' as metabase.
(2,1,1,1)3. H. as metabase.
(2,1,1,1,3)1. H. as probase.
(2,1,1,1,3)2. Geogens as probases.
(2,1,1,1,3,2)1. One epibase.
(2,1,1,1,3,2)2. Two epibases.
(2,1,1,1,3,2)3. Three epibases.
(2,1,1,1,3,2)4. Four epibases.
(2,1,1)2. Complex metabases.
(2,1,1,2)1. C_mH_n— nuclei as metabases.
(2,1,1,2,1)1. One complex metabase (and two elementary
(2,1,1,2,1,1)1 nuclei as metabase.
(2,1,1,2,1,1)2. C
tabase.

Condition of the Tin in the Stannethyl compounds.

possible that Tin also offers us instances of salts in which it acts as a probase to thylous epibases.

456. I have before mentioned* the uncertain constitution of the very complex bases of Löwig which contain Tin and Ethyl, and have suggested that one or more of them may possibly be or contain epibases. If, as seems to me possible, the compound $(C_4H_5)_3,Sn_2$ be an epibase, generating with Hydrostyles salts of the form $(C_4H_5)_3Sn_2;H:St$, this same epibase may exist in the salts of Löwig's "Acet-stannethyl"† $(C_4H_5)_3Sn_4$ with the molecule Sn_2 or Sn.″, as we may represent it,‡ for a probase instead of H. If so, the salts of this base would be of the form $Æ_3,Sn''_2;Sn''_2:St_2$ having Sn.″ both probasic and antistylic in the same compound. We must bear in mind that this base has not been isolated. If such were the case, this suggestion would lose its plausibility, because we do not yet know a single base of this form that exists as a free substance. It is, however, possible that Acet-stannethyl is itself an epibase having the molecule $Æ,Sn$, which we know to be basic, in each of its metabasic places. If so, its salts would be $(Æ,Sn)_2$, $Sn;H:St$ having one atom of H. more than has been assigned to them. We may here notice that

* § 278, p. 287, and § 328, p. 329. † See p. 289.

‡ We already know that Sn. is ditimious, having the molecular value 59 in its lower salts, and 29·5 in its higher salts; for there are obviously two forms of its second oxide, one of which is an epistyle, and is properly represented as SnO_2, while the other is saline, and should be written $Sn':O$. It is not unlikely that it is tritimious, and so, perhaps, in these compounds, has the third equivalent weight $Sn''=118$

It is possible that "Methstannethyl," $Æ_3Sn_2$, may be a base, with Sn. in the probasic, and also in the antistylic place, having, that is to say, salts of the form $Æ_3$, Sn; Sn: St. This may not seem likely, because if $Æ_3Sn$, were an epibase, as this formula would require, it might be expected that it would have been isolated, which is not stated to be the case. Again, the simple molecule Sn., though the metal Tin is nearly allied to Antimony, does not imitate the molecule Sb. in forming tridactylous compounds either with O. or with H. Tin rather follows Hydrogen in its analogies, Antimony represents Nitrogen. It may, however, turn out that Sn_2 or Sn." has, like Sb., the property of combining three basic molecules to produce bodies analogous to H_3N.

457. In discussing the salts of Löwig's Plumbethyl* $Æ_3Pb_2$, I have suggested that they may contain Pb. in the probasic state, with a molecule of $Æ_2$, Pb, appended to it as an epibase. The salts in question are probably analogous in composition to those of Methstannethyl, so whatever theory explains the one will probably apply to the other also. and of the lead in Plumbethyl.

458. Of the more complex epibases of organic origin, a few have been indicated as having the property of combining with metallic salts. The epibasistyles thus formed are generally mentioned as peculiar or abnormal compounds. It is evident, however, that they are perfectly in rule, being instances of the general law that under favourable Epibases united to metallic salts are normal.

* See § 273, p. 282; § 280, p. 291; and § 323, p. 322.

conditions epibases attach themselves to probasi molecules when the latter are united to a style. O this kind of structure the following are instances:—

*Urea with nitrate [nitrute] of silver $\left(\begin{matrix}H_2\\CO\end{matrix}\right\},N)$ Ag:O;N,O_5. and $\left(\begin{matrix}H_2\\CO\end{matrix}\right\}N)_2;(Ag:O;N,O_5)_2$.

†Cafeine with Nitrate of Silver and with Chl ride of Mercury [hermini chlorade] $C_{16}H_{10}O_4N_4$ Ag:O;N,O_5 and $C_{16}H_{10}O_4N_4;(Hg':Cl)_2$.

‡Strychnine with Chloride of Mercury and wi Cyanide of Mercury [hermini cyade] $C_{42}H_{22}O_4N_2$ $(Hg':Cl)_2$ and $C_{42}H_{22}O_4N_2;(Hg':Cy)_2$.

Bases of type $(B_4N)_2;Mb.$ argue against Ammonium hypothesis.

459. The instances which I have cited in the l few paragraphs are earnests to us of a whole ran of salts yet to be studied, containing metallic pr bases united with the epibases that contain carb nous metabases. And it is worthy of note as be ing on the "Ammonium" theory, that of the f complex salts of this kind which are accurat described, by no means a majority contain ba of the form B_4N or $B_3,N;Mb$. But the bases several of these salts are of the form $(B_3,N)_2;M$ thus confirming the notion that this latter form at least as determinate a type as the former. Aga others of these compounds are double salts, havi basic systems of the figure $B_3N;Mb_2$, which by means argue in favour of a regular B_4N type, rather seem to bear additional testimony against

* Werther, Ann. der Chem. und Pharm., b. lvi. s. 262.
† Nicholson, Memoirs of Chem. Soc., vol. iii. p. 326.
‡ Abel and Nicholson, Qu. Journ. of Chem. Soc., vol. ii. p.



APPENDIX.

462. However, before Hofmann's discovery a few instances of combination had been observed, which now that we have learned this fact admit of the interpretation, which hitherto had not been suggested for them, that in these cases thylic molecules exert probasic attachment for the epibase Ammonine. Thus Wurtz* had informed us that the Cyanic ethers [Thylicyates] unite directly with H_3N. Thus— As in Wurtz's Cyanic Ethers.

$H_3N + C_2H_3{:}O;C_2N,O$ forms $C_4H_6N_2O_2$.

$H_3N + C_4H_5{:}O;C_2N,O$ forms $C_6H_8N_2O_2$.

$H_3N + C_{10}H_{11}{:}O;C_2N,O$ forms $C_{12}H_{14}N_2O_2$.

Wurtz compares these bodies to Urea, which is the non-saline form which Cyanate of Ammonia [Nitrino cyate] spontaneously assumes. Thus he considers these to be Ureas, in which one molecule of H. is replaced respectively by C_2H_3, C_4H_5, and $C_{10}H_{11}$. Either, however, they are exactly analogous to Urea, that is to say, double epibases, or they are true salts. If they are true salts, they must be either of the form $H_3N;Thy{:}O;C_2N,O$ or $\left.\begin{matrix}Thy\\H_2\end{matrix}\right\}N;H{:}O;C_2N,O$. In the former of these two salts we have the thyles in the probasic places with the epibase H_3N adhering to them. In the second case we have the salts of the new thylous epibases, which are actually obtained by distilling these compounds with $K{:}O;H,O$. And these new epibases must have been formed by an internal mutation between the H. and the thyles. The phenomena are precisely parallel to those of Hofmann's substitution which we shall presently notice; the $O;C_2N,O$. of

* Qu. Journ. Chem. Soc., vol. iii. p. 91; Comptes Rendus vol. xxvi. p. 368, and vol. xxvii. p. 241; L'Institut, 1849, p. 258

Wurtz being represented by the Br. of Hofmann. If, however, these bodies be Ureas, in which the bipolar salt-nature has disappeared, they must be supposed to have arrived at this condition by the same process by which common Urea is produced from $H_3N + H:O,C_2N,O$. We suppose that in this instance Cyanate of Ammonia [Hydronino cyate] is first formed by the adhesion of the epibase H_3N to the probase of the hydrostyle $H:O;C_2N,O$, Cyanic [Cyaric] acid. So in the case of our thylous compounds, the first step in the formation of the new Ureas will be the formation of complex salts [Hydronino-thyli cyates] by the adhesion of the H_3N, to the thyles (C_2H_3, etc.) of the thylistyles. The compounds formed by the action of H_3N on $C_{12}H_5:O;Cy,O$ [Cyate of Fenyl*] and on $C_6H_5:S;Cy,S$ [Sulfocyate of Allyl†], may be supposed in the first moment of their formation to exist as epibasepistyles, having respectively the hypobases $C_{12}H_5$ and C_6H_5 in the probasic position. Both of these compounds, however, immediately pass out of the saline or bipolar form, the first into that of a double neutral parahale "carbamide-carbanilide," the second into the epibase "Thiosinnamine." Again,‡ Cahours§ had found that the compound

* Hofmann, Qu. Journ. Chem. Soc., vol. ii. p. 316. See § 409, p. 405.

† See § 416, p. 411.

‡ Ann. de Chim. et de Phys., ser. 3, vol. xxv. p. 9.

§ Indeed M. Cahours himself states that this Binitrosalicylate of Methyl, and even the Salicylate of Methyl, act as acids, and he calls them Binitrogaultheric and Gaultheric Acids. However, the term acid is somewhat loosely applied by this distinguished

$C_2H_3:O;C_4\left\{\begin{matrix}H_3\\(NO_4)_2\end{matrix}\right\},O_5$, produced by the action of $H:O;SO_3+H:O;NO_5$ on Salicylate [Salisute?]

ether, as well as by most chemists; so that it is necessary to consider how far our definition of the term will permit us to predicate acidity of these compounds. We must first observe that neither the Salicylate of Methyl, nor that of Ethyl, acts as an acid in the sense in which we have just seen that their nitrogenous derivatives behave so. Neither of the former bodies combine directly with H_3N, therefore they are not, like the latter compounds, probasistyles. But the two former salicylates are said to act as acids towards the metallic oxybases, forming thus salts of the several metallic bases. Now, if the true constitution of these bodies be $Thy:O;C_{14}H_5O_5$, that is, having a thylic group for their bases, as Cahours seems justly to infer, it is quite clear that they cannot act as hydrostyles, since they have not H. for their base, and so cannot in that sense be acids. Neither is any single molecule of their H. replaceable by a metallic base. Neither do they act as acids in any sense which implies the total displacement of their basic molecules by a new base, since the whole of their substance is found in the compound which they form with the oxybases. Thus, the compound formed by adding $C_2H_3:O;C_{14}H_5,O_5$ to an aqueous solution of $Ba:O$, contains both the substances which I have represented in symbols. This is not the behaviour of a simple acid towards a simple oxybase; such bodies effect a double mutual decomposition, yielding two compounds, each of which contains one member of each basistyle of the original pair. Do, then, these salicylic ethers [Thylisalisutes] combine with the oxybases, according to the manner of the so-called "anhydrous acids," the epistyles: so that the whole of their substance lies on the voltanegative side, and so that the Ba. compounds would be truly represented thus, $Ba:O;C_{14}H_5,O_5.Thy,O$?

This conclusion is negatived by all the habits of these compounds; their behaviour indicates that their Thy. still remains basic in their metallic salts. It remains, then, for us to conclude that these metallic compounds are double salts of the form $\frac{Mb\uparrow O;C_{14}H_5,O_5}{Thy\downarrow O}$, in which the basic thyle (Thy) is probably

of Methyl ($C_2H_3:O;C_{14}H_5,O_5$?) combines directly with H_3N, forming the compound

$$H_3N;C_2H_3:O;C_{14}\left\{\begin{matrix}H_3\\(NO_4)_2\end{matrix}\right\},O_5.$$

In this and in the corresponding Ethyl-compound, C_2H_3 and C_4H_5 respectively seem certainly to be

displaced by the metallic base (Mb.); but, taking the O. of the metallic oxybase, adheres as an oxide to the new salt, just as H:O adheres to numerous metallic salts. The formation of this compound well illustrates the tendency of the oxythyles (ethers) to generate double salts. This view explains at once how, on heating these metallic compounds, the alcohols are evolved; the metallic double salt is broken up, and the detached Thy:O, forms an aqueous double salt or alcohol. Thus $\frac{Mb\uparrow O:C_{14}H_5,O_5}{Thy\downarrow O} + HO = Mb:O;C_{14}H_5O_5 + \frac{H\uparrow O}{Thy\downarrow O}$. It seems, then, that it is an error to state that these Thylistyles act as acids.

The same considerations that apply to the salicylic ethers [thylsalisates] hold good with respect to their [nitromious] derivatives, in which NO_4 is substituted for H., so far as concerns their metallic salts. One of the metallic compounds, however, which are obtained in this group, seems to belong to a different and very remarkable type. This is the "Binitrogaultherate of Silver" of Cahours, to which he assigns the composition $C_{16}H_5AgN_2O_{14}$, but of which he does not suggest the constitution. Now, the composition of the salt of Barium corresponding to the formula above assigned to the metallic Thylisalisates would be $C_{16}H_6BaN_2O_{16}$, containing one molecule more of H., and of O. The Silver salt, in fact, differs from this Barium salt just as the oxide of Silver differs from that of Barium under ordinary circumstances in being without H:O. Now, as the only change which we know to take place here, in the introduction of a metal into the compound, affects the basic side of the salt, we are warranted in believing that the stylic side remains unaltered, except in the abstraction of Oxygen therefrom. Now, the only way in which we can deduct the corresponding Hydrogen from the basic side of one of these compounds is by taking it from the thyle itself. This we

probasic, and the binitro-salicylate [dinomisalisute] of Methyl and Ethyl seem to act towards the H_3N precisely as acids would behave with that epibase.

463. Strecker* had informed us that the epibase H_3N unites with the sulphate [sulfite] of Ethyl $C_4H_5{:}O;SO_3$. But the result of this union is not, it would seem, a compound of the form must do in the case of the Binitrogaultherate of Silver. I do not see how we can account for the construction of this body under the composition assigned to it, except by supposing that in it Ag. replaces one of the atoms of H. in the C_2H_3. If this body were correctly analysed, it must, I imagine, have the form $C_2H_2;Ag{:}O;C_{14}\left\{\begin{matrix}H_3\\(NO_4)_2\end{matrix}\right\},O_5$. This is a most suggestive formula. It may remind us of a compound which we noticed in a preceding page (see note to § 346, p. 345), in which a metal having the closest affinity with Silver (Hg') appears to replace Hydrogen in ethyl, a molecule closely akin to the methyl, which here seems to have suffered partial substitution (see also § 269, p. 279). We must not, however, conclude that if this is the true constitution of this compound then the constitution of the metallic compounds that contain one equivalent more of H:O must be $\dfrac{C_2H_2;Mb{:}O;C_{14}\left\{\begin{matrix}H_3\\(NO_4)_2\end{matrix}\right\}O_5}{H{:}O}$; for all metallic bases are not, like Ag., strongly probasic.

Probably also Ethyl Strecker's salt is probasic.

It would appear, then, that under the term binitrogaultherates three distinct forms of salts are included; these may be represented thus, taking Mb. to represent a metallic base, Ab. the antibasic molecule $\left(C_{14}\left\{\begin{matrix}H_3\\(NO_4)_2\end{matrix}\right\}\right)$ of "Binitrosalicylic" Acid, and Thy. an ethyloid molecule:—

(1) $\dfrac{Mb{:}O;Ab,O_5}{Thy{:}O}$

(2) $(Thy-H)Mb{:}O;Ab,O_5$

(3) $H_3N;Thy{:}O;Ab,O_5$

whereof the last appears to afford an instance of a probasic thyle.

* See Annales de Chem. und Pharm. 675, s. 46; Liebig's Ann. Rep., Eng. tr. iv. p. 282.

$H_3,N;C_4H_5:O;S,O_3$, or $\left.\begin{matrix}C_{14}H_5\\H\\H\end{matrix}\right\}N;H:O;SO_3$. But a more complex molecule is obtained, in which, according to the account we have of it, C_4H_4 would seem to be neither probasic nor metabasic. It consists of $2(H_3N)+4(C_4H_5;O;SO_3)$; and of the H_3N thus taken up only one-half is precipitated by $H:Cl;Pt,Cl_2$ as $H_3N;H:Pt:Cl_2$. From this Strecker infers that only one-half of the H_3N is on the basic side, the other half of it and all the Ethyl entering into the constitution of the "acid" [style?], producing a very complex acid, to which he gives the epithet "Ethamine sulfuric." However, an alcoholic solution of the mixture of the H_3N salt with $H:Cl;Pt,Cl_2$ yields by evaporation the salt $\left.\begin{matrix}C_4H_5\\H\\H\end{matrix}\right\},N;H:Cl;Pt,Cl$. This reaction indicates that part of the C_4H_5, though it has left its position as a base, is still on the basic side, having in fact become metabasic. This will enable us to account for the formation of the salts of K, Na, Br, etc., the "ethamine sulfates," by simple displacement of $H_3N;H:O$ by the metallic oxybases without supposing the acid to contain the molecule $C_{16}H_{23}NO_4$ on its negative side. Thus the salt formed by the union of the H_3N with the $C_4H_5:O;SO_3$ may have the constitution

$$\left.\begin{matrix}H\\H\\C_4H_5\end{matrix}\right\},\begin{matrix}N;C_4H_5\,|\,O;S,O_3\\C_4H_5\,|\,O;S,O_3\\C_4H_5\,|\,O;S,O_3\\H_3N;H\,|\,O;S,O_3.\end{matrix}$$

this is the true constitution of the compound, e here have one molecule of its Ethyle in the robasic condition.

464. From what we know of the behaviour of he styles which are less readily expelled from the asic position than is H., we may conclude that a uch smaller amount of force might suffice to ubstitute a metallic molecule by double decomosition for the fourth base in such a quadruple alt than would be necessary to dislodge the other asic molecules. So that this is perhaps a multile salt having Ethyl in a probasic position.

465. Perhaps, again, in the compound formed by saturating hydrated oxide of Fenyle with H_3N, we have an instance of a double salt in which a thylic molecule Fn is probasic. I suppose the true formula of this compound to be either $\frac{H_3,N;C_{12}H_5\,|\,O}{H\,|\,O}$ or $\frac{C_{12}H_5\,|\,O}{H_3,N;H\,|\,O}$. The former is the more probable of the two, because liquid "Carbolic Acid" does not combine with aqueous $H_3N;H:O$, which might have been expected to yield with it a compound of the latter form, even though it does not produce such a salt as $H_3N;H:O;C_{12}H_5,O$.* These are instances of combinations from which the probasic capabilities of the thyles might have been, but were not inferred. I am not aware, indeed, whether these compounds have been before considered under the light which Hofmann's discoveries have thrown upon the properties of the molecules concerned in them.

Fenyle may also be probasic.

* See § 262, p. 257.

Hofmann's results.

466. Let us now consider the steps by which Hofmann has led us up to this most interesting point of the physiology of the epibases. He first showed that, like the corresponding hydrostyles, the bromides and iodides of Methyl, Ethyl and Amyl were able, under appropriate temperature and pressure, to assume to their basic member the epibases H_3N, and $C_{12}H_5,H_2N$, forming complex salts as truly as do the acids proper.* But he found on breaking up the salts so formed, by treating them with the oxides of stronger bases, that the epibases separated from their points of attachment and that they now contained the molecule which we may say seemed to have been probasic transferred to the metabasic position by interchange with Hydrogen.† And now salts precisely similar to those obtained by combining the original epibases with the thylistyles were yielded by the union of the new thylous epibases with the hydrostyles. Thus on treating C_4H_5:Br with the epibase $\left.\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right\}N$, a compound is produced which we might consider to be $\left.\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right\}N,C_4H_5$:Br, with C_4H_5 as its probase. But on treating the solution of this bromide with $\frac{K\,|\,O}{H\,|\,O}$ we do not reproduce Aniline [Monofenine] and obtain Alcohol according to the equation—

* Phil. Trans., 1850, part i. pp. 99, 119.

† See § 299, p. 308.

$\left.\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right\}N;C_4H_5:Br+\frac{K}{H}\Big|\frac{O}{O}=\left.\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right\}N+K:Br+\frac{C_4H_5}{H}\Big|\frac{O}{O}$

but we get Ethylaniline [Hydrethyfénine] and water, thus, $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\}N+K:Br+2(H:O)$; and by treating the new epibase $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\}N$ with H:Br we obtain the same salt that we had before the action of Potassa, which salt we are thus invited to consider as $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\},N;H:Br.$

Similar results were yielded by the new epibase $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\}N$, which on union with the thylistyle $C_4H_5:Br$ and subsequent separation by K:O;H,O generated the new epibase $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\C_4H_5\end{matrix}\right\}N$; and by such reactions Hofmann constructed his extensive series of epibases, in which, as in the instance last cited, each of the atoms of Hydrogen in H_3N were expelled by a thylic molecule. But though in these reactions the thyles seemed to be displaced from their basic position by the Hydrogen, whose metabasic place they were compelled to take in the epibases, yet under other treatment the original epibases could be separated unchanged. Thus when the compound produced by the annexation of $\left.\begin{matrix}C_{12}H_5\\H\\H\end{matrix}\right\}N$ to $C_4H_5:Br$ is subjected to dry distilla-

tion, the two original constituents are recovered.* Similar decompositions are effected by heat in the case of several of the salts generated by the union of the thylistyles with the epibases of the form $\left.\begin{matrix}\text{Thy}\\\text{Thy}\\\text{H}\end{matrix}\right\}\text{N}$. So that here we had hints that in salts having complex bases, the thyles may yet fill the place of probases.

In some of these, probases are not thyles.

467. There were, however, some other remarkable points of deportment in the case of certain of these compounds which would prohibit us from concluding that the basic molecule of the original prothylistyle† is always probasic in the new complex salt. Thus both the compound formed by the annexation of $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\}$,N to $C_{10}H_{11}$:Br, and that resulting from the union of $\left.\begin{matrix}C_{12}H_5\\C_{10}H_{11}\\H\end{matrix}\right\}$,N with C_4H_5:Br yield by distillation the epibase $\left.\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right\}$,N, and the thylistyle $C_{10}H_{11}$:Br, although either of the same complex salts, when treated with K:O;H,O yields the epibase $\left.\begin{matrix}C_{12}H_5\\C_{10}H_{11}\\C_4H_5\end{matrix}\right\}$,N.

Though some of these phenomena seemed to render it almost certain that the thyles could act

* Op. cit., p. 101.

† By this term I mean, of course, probasistyle, of which the base is a thyle.

wel shall have no meaning in our
onnection with the consonant which
hen, we commence a word with a
id will not at all affect the signifi-
n. Now we may construct a very
ouble consonants which can be pro-
wel preceding them. Some of these
e final sounds of words, others can
ced with another vowel following
purpose, however, we need draw no
en the two kinds of sounds, as we
ny of them at the ends of our words,
e elements: since these are always
y a numeral vowel. We may then
g elements in turn, and select, for
of this sort, as its symbol. And we
, when such symbol is the first of a
form a compound word, it shall be
auxiliary vowel, such as any short
of the English words "bat," "bet,"
ot," or "her," that may be conve-
iation with the usual name of the
facility of pronunciation. When
ccurs not at the beginning of a word,
l of the preceding syllable will be
n the consonant, without any adven-
ng the old symbols we have still re-
is head, these four, which we may
usual significations, *cd*, *mn*, *nb*, *pt*,
persons may perhaps pronounce as
we may then make the following
ch are all obviously suggested by the
rrent names of the elements:—*lm*

bromades] with which he was experimen
brought in contact with the epibases of
Thy_3,N,—in which there was no more
Hydrogen to be replaced, and in which the
further interchange between Hydrogen
and consequently, no formation of acid cou
pected,—there were still evidences of com
He further discovered, on substituting th
compounds [thyli-iodades] for those of
that the new epibases combined with som
bodies with the greatest readiness. In
iodide of Ethyl [Eth-iodade] acted tow
ethylamine [ethynitrine, or ethynine] in
mode in which the iodide of Hydroge
iodade] behaves towards Ammonine [hy
there was a difference in the degree of en
the combinations were clearly of the sa
There was also a difference between the t
themselves, in the degree in which the
this attachment. Thus while $(C_4H_5)_3,N$
instantly, when aided with slight heat, to
and C_4H_5:I, it required the persuasion
temperature continued for days to indu
lar quantity of it to combine with its e
of $C_{10}H_{11}$:I. In this manner Hofmann
a series of salts, whose various species it
cessary here to catalogue, but to which,
mode of their construction, we are entitl
sign the constitution expressed by the
$\left.\begin{matrix}\text{Thy}\\\text{Thy}\\\text{Thy}\end{matrix}\right\}$N:Thy;St., in which all the mol

Thyle (Thy) may be of the same or of different species.

469. That is to say, we have here salts of complex bases, in which the one probasic and the three metabasic molecules are all thyles of which, four, all, or any less number may be the same or different from each other. The constitution of these bodies is well illustrated in some instances by their decomposition under heat; some of them are separated by dry distillation into the original epibase and thylistyle of which they were constructed. But here is one feature in which these salts differ very remarkably from those which Hofmann had previously presented to us, even from those of his first series, which most nearly approach to these in composition. Of none of the former kind which contain Hydrogen, either as metabase or as probase, was the cohesion of the basic member sufficiently strong to give it stability under the feeble tylic induction of Oxygen. All of those when treated with potassa, were split up, liberating epibasic molecules. But these new iodides when presented to an oxybase (Ag:O) which can interchange its Oxygen for their Iodine, are converted into oxides [oxades] of remarkable permanence. And these oxides show by their remarkable properties, that to the stability of their basic molecules their chemical energy is fully coordinate. These oxides, in fact, manifest the power of their bases by their alkaline solubility in water and causticity, and by the eagerness with which they assume epistyles,

The metabases as well as probases may be thyles.

even the weaker ones, such as CO_2 for the complication of their stylic members. The positive energy of the bases in some of these salts is so great, that they are not detached in the way of double decomposition, even by potassa, from the halogens with which Potassium is most eager to combine. They can be decomposed only by those oxybases whose bases will precipitate with the styles of these new salts. Thus, Hofmann says, speaking of the compound $(C_4H_5)_3N;C_4H_5:I$, "the molecular group here combined with Iodine behaves like Sodium or Potassium."* It may, in fact, by double decomposition, be brought into combination with any stylic molecule, simple or complex, manifesting towards such a most energetic attachment.

The new alkalies act like Potash where the probase is a thyle.

470. The chemical behaviour of these new alkalies as illustrated by the oxide of tetrethylammo-

* He adds, I think unfortunately, "It is a true organic metal in all its bearings. For this metal I propose the name Tetrethylammonium" (Phil. Trans. 1851, pt. ii. p. 361). This is a misapplication of the term metal. The complex base of these salts [the ethynine-ethystyles] is, in the first place, utterly unknown as an isolated body; next, not one of the reactions of the compounds into which it enters gives the least indication of a probability that the base will be isolated, still less have we any reasons for supposing, that if isolated it would have a metallic appearance physically. Again, chemically, it does not correspond to "a metal" in the abstract, it has no resemblance in function to Platinum, Gold, Arsenic, or Titanium. It does represent Potassium, Sodium, and Silver, in its functions; but these are only a minority among the metals. It represents the metallic bases, and not only represents these, but it is a base perhaps as strong as any of them. It would be at least as logical to say that certain of the metals approach to it in chemical position, and are therefore "true elementary bases."

amum [ethynine-eth-oxade] is extremely instructive. We find that in its reactions with metal salts it resembles Potassa, and does not imitate Ammonia in those points in which this complex alkali differs from the former oxide. Thus it precipitates the oxides of all the basic metals which in that form are insoluble in water. An excess of it redissolves certain of these precipitates which have an epistylic tendency, such as Zn:O,—Pb:O—Sn:O,* but it does not, like $H_3N;H:O$, and $\left.\begin{matrix}C_2H_3\\H_2\end{matrix}\right\}N;H:O$, dissolve the oxides of the probasic metals Copper and Silver, though, like potassa, it will effect the solution of Cu:O in water with the aid of sugar. M. Wurtz† has informed us that Methylamine [Monomethynine] water does dissolve the precipitated oxides of Cadmium, Cobalt and Nickel, and that the corresponding Ethyl alkali dissolves the copper-oxide less readily than does the former body. We thus see the epibasic attachment for metal salts, which is so strongly marked in H_3N, considerably weakened in its carbonous congeners. However, the insertion of $C_{10}H_{11}$ into the epibasic molecule does not destroy this tendency, for M. Wurtz tells us that $\left.\begin{matrix}C_{10}H_{11}\\H_2\end{matrix}\right\},N;H:O$ dissolves Cu:O, and Ag:O, but less readily than do his two other alkalies. In Hofmann's last alkalies, however, this property is quite extinguished. The reason is obvious. In these compounds the probase is no

* Op. cit., p. 364.

† Qu. Journ. Chem. Soc., vol. iii. p. 94.

longer Hydrogen but a Thyle. The probasic metals cannot enter into solution in the alkali without taking the place occupied by the probasic molecule, and cannot expel the Thyles from this position from which they could displace Hydrogen. The peculiar stability of these last complex bases, on the one hand, shows us that the attachment of the epibase to the probase is in these oxides stronger than in $H_3N;H:O;$, and on the other hand we had long ago learned from the various Ethers [Thylistyles] that the Thyles adhere to the Halogens, when once united to them, with greater pertinacity than does Hydrogen. Thus some of the Thyles certainly exceed Hydrogen in some of the powers, in the exertion of which lies their resemblance to that element.

The voltalysis of these bodies needed.

471. It is probable that the subjection of some of these complex salts to voltalysis would yield some interesting results. Hofmann, however, is not very encouraging on this point. "Although," he says,* "I did not anticipate great results from the experiment, I have submitted the new base [oxybase $(C_4H_5)_3,N;C_4H_5:O$] to the action of the galvanic current, the pile being disposed as in Berzelius's original experiment on the formation of the ammonium amalgam. However, no phenomenon other than the decomposition of water was observed." From what the discoverer of the new alkalies had said just previously about† the organic metal contained in the salt which he was examining, it is quite evident that what he here meant

* Op. cit., p. 364. † See note, p. 500.

y "great results" was the appearance of a metal t the cathode. One can scarcely help suspecting hat he entertained the notion of the possible for- nation of a compound body with metallic lustre in his voltalysis, and that, though he did not antici- ate so splendid a creation, it was the absence of t that to him was "no phenomenon." The ex- eriment was probably tried only incidentally, as piece of byework, not with the determinate view f arriving at its results, whatever they might be. t may, then, still be said, with perfect deference o Dr. Hofmann, that the experiment may fairly be epeated, with the purpose of observing the mode n which the basic member decomposes, when letached by the voltaic induction from its stylic ympole. It appears from the statement just cited, hat the substance was tested with the pile in the resence of water. The refusal of the salt to de- ompose, while water suffered voltalysis, only indi- ates that its halopoles are less easily sundered han those of the liquid which was mixed with it.

472. In the conclusion of the account of his new omplex salts, Hofmann further informs us briefly* hat the bodies leucoline or quinoline ($C_{18}H_8N$), oniine ($C_{17}H_{17}N$), and nicotine ($C_{10}H_8N$), adhere o the methyl-iodide, forming the crystalline salts f new complex bases, behaving, indeed, towards his thylistyle just as they would towards a hydro- tyle or true acid. The mention of this fact is uite sufficient, I conceive, to demonstrate that

Leucoline, etc., are epibases.

* Op. cit., p. 393.

these bodies are not alkalies, "alkaloids," or "bases" in any such sense as any metallic oxides are, and to entail upon us the immediate necessity of applying to them some general term, such as "epibase," that will distinguish them altogether from such oxybases, as well as from the metallic bases which the latter contain. This combination, in fact, demonstrates that leucoline, coniine, and nicotine belong to our class of epibases, and are so removed from the doubtful region in which many of the so-called "organic bases" must for the present remain.

Thyles as probases where Sb. and As. are the antistyles.

473. A beautiful sequel to this discovery of Hofmann's, that the thyles can act as probases to the epibases having Nitrogen for their antistyle, was the demonstration by Löwig, Schweitzer, and Landolt, that they exercise the same function towards the new epibases having Antimony or Arsenic for their antistyles.* In a former page I have noticed these remarkable compounds. The instability of the constitution of Stibmethyl (Me_3Sb) [Methystibine or Methysbine] and Stibethyl [Ethysbine] $Æ_3Sb$, seems to be such that their nature is altered by contact with H:Cl. Under the action of this energetic acid, Stibethyl assumes a basic deportment, expels Hydrogen and combines with the Chlo-

* See § 316, p. 317. Qu. Journ. Chem. Soc., vol. v. p. 67; Watt's Tr. Gmelin's Handbook of Chemistry, vol. vii. p. 322, and Gerhardt's 'Traité de Chimie Organique,' t. ii. p. 949, contain abstracts of, and references to, the original papers. See also Annalen der Chem. und Pharm., b. lxxxiv. s. 44.

rine. Similarly, the compound $(C_4H_5)_3As$ is not epibasic to H:Cl. But when treated with the Thylistiles, which are more inert and less easily decomposed than the Hydristiles, these tridactylous metallostyles unite with them as true epibases. Thus, our $(C_4H_5)_3$, Sb, combines directly with C_4H_5:I, and forms the complex salt $(C_4H_5)_3$ Sb; C_4H_5:I, [Ethysbine-eth-iodade]. Stibmethyl [Methysbine] Me_3Sb, combines in precisely the same manner with Me:I, forming the salt $(C_2H_3)_3Sb.C_2H_3$:I [Methysbine-methyl-iodade]. And $(C_4H_5)_3$ As, forms with C_4H_5:I, the epibasistyle $(C_4H_5)_3$,As;C_4H_5:I [Etharsine-eth-iodade]. These salts are perfectly analogous to those having the basic molecules H_3N:H or K. The Iodine may be exchanged for other halogens, or for complex stylic molecules. The oxides, which are formed from the iodides by treating them with silver-oxide, are oxybases, the energy of whose basic molecules is manifested by the stability of these oxides in water, and by their ready combination, as strong alkalies, with the epistyles, even with CO_2. Like the corresponding salts of Hofmann, which contain antistylic Nitrogen, these alkalies dissolve the metallic oxybases that have an epistylic tendency (Zn:O,—Al′:O). But they do not dissolve the oxides of the probasic metals such as Copper and Silver. Here, as in the analogous cases before noticed, the probasic Thyles cannot be expelled, at least not offhand in the cold, by the metallic molecules. It is, however, by no means improbable that some of these com-

plex alkalies with thylic probases may be made to dissolve these metallic oxides, with aid of moderate heat and time, with the formation of the corresponding alcohols. Thus :—

$$\frac{(Thy)_3Ast;Thy\,|\,O}{H\,|\,O} + Cu{:}O = (Thy)_3Ast;Cu{:}O + \frac{Thy\,|\,O}{H\,|\,O}.$$

Voltalysis of Iodide of Stibmethylium.

474. The behaviour of a compound under the action of the voltaic current, is always a most interesting point in its physiology. It is one to which attention is so seldom paid, that a record of it, when such is to be found, is most valuable. It is peculiarly so in the case of complex compounds containing hydrocarbonous molecules, as the direction taken by such constituents is of prime importance in determining the nature of the substance. We are told by M. Landolt* that the Iodide of Stibme-

* Ann. der Chem. und Pharm., b. lxxxiii. s. 56. The words of the experimenter are : "Das Iodstibmethylium zeigt gegen den electrischen Strom ein ganz merkwürdiges Verhalten. Wird eine wässerige Lösung desselben der Electrolyse unterworfen, so scheidet sich am negativen Pol Iod, und ausserdem eine kleine Menge von Sauerstoffgas aus, an der positiven Electrode tritt dagegen eine reichliche Gasentwicklung ein, während zugleich die Flüssigkeit milchig wird, eine alkalische Reaction annimmt, und nach Stibmethyl zu riechen beginnt. Das am positiven Pol entwickelte Gas, welches an Volum ungefähr das Zehnfache des am andern Pol ausgeschiedenen Sauerstoffgases beträgt, ist antimonhaltig ; es besitzt den Geruch des Stibmethyls in einem ausgezeichneten Grade, und lässt sich leicht unter Abscheidung eines weissen Rauchs entzünden. Wird dasselbe mit einer alkoholischen Iodlosung geschüttelt, so verschwindet die Farbe desselben, und es tritt eine Volumverminderung des Gases ein. Diese Verhältnisse führen auf die Vermuthung dass der gasförmige Körper reines Stibmethylium seyn konnte ; obschon seine phy-

lium ($(C_2H_3)_3Sb;C_2H_3:I$) [Methysbine-meth-
ıde] is a true voltalyte, being decomposed under
action of the pile into Iodine, which escapes at
anode, while the whole of the Carbon and Hy-

lischen Eigenschaften von denjenigen der durch Destillation
Iodstibmethylium mit Antimonkalium erhaltenen Verbin-
g abweichend sind. Die nähere Untersuchung musste leider
en Mangel an Material unterbleiben. Da an einem Pol
erstoffgas erscheint, findet zugleich noch Wasserzersetzung
."

t must be remarked here that the phenomena do not the least
ify the inference of Landolt, that either "pure Stibmethy-
n" (Me_4Sb) or Stibmethylium at all, was obtained in this
tion. There is equally little evidence of the production of
such compound, by the distillation to which he refers, of
$_3Sb;Me:I$ with KSb. Of the result of this other process the
nty information that he gives us is best summed up in his own
ds, thus: "Das erhaltene ölige Product zeigte viele Aenlichkeit
dem Stibmethyl," p. 47. In fact there is every reason to believe
t this substance was not $Æ_4Sb$, but $Æ_3Sb$, and nothing else.
In the case of the voltalytic experiment, the facts above stated
explicable in no way so clearly as by the supposition, sup-
ted by all analogy, that the voltapositive molecule, in the act of
aration from the halogen, is subdivided into its constituents
$_2Sb$, and Me. The former compound, the epibase, is a vola-
oil, insoluble in water. The latter is a gas. The oil would
ke the aqueous liquid milky, by virtue of its insolubility (and
aline by its epibasicity); and by its volatility it would satu-
e with its vapour the gas that was evolved in contact with it.
is vapour would notably increase the bulk of the gas, and
uld confer upon it its own spontaneous inflammability and its
our. We know that Me_2Sb, can act as a basic body, so that
combination of its vapour with the Iodine presented in alco-
lic solution to the gas would sufficiently account for the diminu-
n of the volume of the latter which followed that treatment.
ere was, of course, among the gas at the cathode, a certain
antity of H., co-ordinate to, in volume double of, the minute

drogen appears at the cathode. Thus far our information is definite, but, as to the arrangement of the C. and H. so obtained, we have no precise statement. We must be thankful for what we can get, and make the best interpretation we can of it. We are not informed of the exact nature of the products yielded on the positive side. But it would seem that a gas, perhaps Methyl, probably entire, and Stibmethyl [Methysbine] were at least among them, if they did not constitute, as is likely, the main bulk of the positive products. No indication of the formation of the actual base Me_2Sb, or Me_4Sb was afforded by this, or by any other experiment, made by Landolt in this direction.

quantity of O. evolved at the anode. But there must have been, besides this small portion, a quantity of other gas not absorbed by the Iodine solution; for we are only told that a diminution of the volume of the gas ensued in the treatment with the Iodine. If all the gas, except the H., had been absorbed, we should have been told so. This individual gas, then, was probably Methyl. To these considerations we may add the high improbability that, if $(C_2H_3)_4Sb$ could exist, it would be a gas, while $(C_2H_3)_3Sb$ is a liquid at ordinary temperatures. Again, the author informs us that another experiment, made obviously with the view of isolating the imaginary "Stibmethylium," yielded nothing that was tangible and new in the way of base. "Uebergiesst man Natriumamalgam mit wässeriger Iodstibmethylium Lösung, so entstehen fortwährend kleine Explosionen, welche von einer Feuererscheinung begleitet sind; dabei wird metallisches Antimon abgeschieden." We may, then, infer, that the wish, which like numerous other chemists, M. Laudolt probably entertains,—the the wish to produce a real "radical,"—was, more than the phenomena which he records, the origin of his belief that he had here secured the base.

These new facts, indeed, drop another weight into the scale of evidence that bases of the form $B_3, Ast; B$, like styles of the form $Ha; Ab, Ha_3$, cannot exist in the isolated state.

475. I have already indicated the possibility that among the remarkable metallothylic compounds of Tin discovered by Löwig, one, namely $(C_4H_5)_3Sn_2$, is an epibase, not a base as he supposes,* and that, in this capacity, it attaches itself to the molecules H and Sn_2 or Sn″, which may act towards it as probases. There is another of these Stannethyl compounds, which by its behaviour indicates distinctly that its base belongs rather to the complex type which we are now considering, than to that of the thylous antibases. This is Löwig's hydrate of Æth-Stannethyl oxide $(C_4H_5)_5Sn_4{:}O;H,O$. Now if we remember that Löwig has informed us that the molecule $(C_4H_5)_2Sn_2$ is itself basic, having, under his name Methylen-Stannethyl, the properties of a weak base intermediate between those of Tin and of Ethyl, it may seem very probable that, like either of these its constituents, it may also enjoy probasic properties. If so, we see at once a probable reason why the base $(C_4H_5)_5Sn_4$ should differ so greatly in its behaviour from $(C_4H_5)_4Sn_4$, Elayl-Stannethyl, which so closely approximates to it in composition, and why it should so nearly resemble in its habits the bases we have just now been considering, such as $H_3,N;H$ and $Æ_3,Sb;Æ$. It perhaps involves the same epibase, $Æ_3Sn''$, which

Löwig's hydrate of Æth-stannethyl Oxide.

* See § 279, p. 289, and § 456, p. 482.



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metabase in salts in which it occurs as probase. And certain epibases with thylic metabases, and metallic antistyles, refuse to adhere to the typical probasistyles,—the prohydrostyles,—and are not hitherto known to combine with any probasistyles except those having thylic probases; but the salts which they thus form, with all the basoid molecules similar, are very stable and have very energetic bases.

Epibases are generally, complex bases, never isolable.

479. We have not found a single instance in which a complex basic molecule, consisting of a probase with one or more epibases, is known in the free condition. We have seen, however, that when any of the salt systems of this form are decomposed, the epibases are usually set free, and that these are for the most part stable bodies. Finally, we have remarked that many of the bases have not a sufficient coherence to form permanent oxides; but that when the system is stable in combination with Oxygen, the resulting compound is frequently a strong alkali, always a very decided prostylobase, eagerly taking up epistyles on its voltanegative side, so as to establish the balance of power in the salt.

CHAPTER VI.

OF A THIRD GROUP OF BASES.

480. Besides the two sorts of basic systems which we have considered, namely, those which are isolable, as substances, and those which contain separable epibases, there are other molecules which fill the same position in salts, but of which neither of these characters can be predicated. There is a third group, to which, for the present, we must provisionally consign every base of which we know the salts, but which has not been, and is not expected to be detached, free and entire, from its stylic sympoles, nor has yielded, on decomposition, substances which, with the aid of a style, can be put together again to constitute the original base. The species of this group are, probably without exception, zoogenous products of organic life. I have already mentioned,* that, under the term "organic bases," two kinds of substances are often confounded, namely, epibases and oxybases. The basic members of the latter bodies are the mole-

Zoogenous in-isolable Oxybases.

* See § 296, p. 304.

cules to which I now refer, as constituting, perhaps alone, this residual section of the class of bases. These oxybases bear to the salt-idea a relation, which is the exact converse of that of the hydrostyles, having styles of the third group of our preiminary arrangement;* they are, indeed, the true antilogues of these "organic acids." Of the two groups, the characteristic halopoles are only known by the complete salts, which they help to constitute.

Their Oxygen may be all Stylic or partly Metabasic.

481. There has frequently been, unfortunately, such an obscurity in the descriptions which chemists have given of their "organic bases," that it is, in many cases, difficult or impossible to decide, from the information in the books, whether a substance, thus termed, is an epibase or an oxybase,—whether, that is to say, it generates salts by combination or by double interchange, with the hydrostyles. This obscurity, of course, only attends those cases in which the substance contains oxygen. If it contain no oxygen, it must be an epibase; there is no other alternative. For the presentation of a real complex base is an occurrence so rare and so marked in its phenomena, that it is not likely to be confounded with compounds of these other kinds. Besides, no free base has ever been obtained among the products of organic life which chiefly yield the bodies of which I now speak. If, however, Oxygen enters into the composition of the doubtful substance, this element may be, in part or altogether,

* See § 175, p. 159.

stylic therein, or, as we have already seen,* it may form part of one or more of the metabasic molecules of an epibase. Perhaps there may be some other function, which it may fill in these basic systems; but at any rate we do not know that it can occupy any other place. Many of these bodies contain two molecules of Oxygen: both of these may be stylic, for the body may be a "hydrated" oxybase, or hydrous double salt, analogous to $\frac{K}{H}\Big|\frac{O}{O}$. But again, two is a favourite number of atoms of Oxygen for metabases; and this must be borne in mind in the consideration of the formulæ.

They probably consist of Probase with Epibase.

482. It is, I think, probable that the bases of these hitherto undissected bodies of this kind, which are oxybases, are in reality constructed upon a model the same as that of the bases of our second group, that is to say, that each of them consists of a probase and an epibase, the latter member being regularly made up of antistylic and metabasic molecules. They all present Nitrogen among their constituents. This fact, connected with the prominent part which this element plays as the typical antistyle in the zoogenous epibases, encourages the notion that it is also antistylic in these other basic systems, to the structure of which it seems to be equally essential.

Is Quinine a hydrated (Cinchonine its anhydrous) Oxybase?

483. Quinine ($C_{20}H_{12}NO_2$) is to be referred, in all probability, to the present group of salts. It is, I conceive, an oxybase, having some such a

* See § 380, p. 374.

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of the "bases" [oxybases] themselves from vulgar materials.* And from the fact that the greater number of artificially-prepared epibasistyles yield their epibases more readily than their oxybases, while the converse is true of the epistylobases, of which the hydrostyles are more easily obtained than the epistyles, we may infer that the preparation of the epipoles of these zoogenous oxybases would probably be effected with less difficulty than in the correlative experiment on the antilogous hydrostyles.

* Chemists seem as much seized, in the present day, with the notion that the manufacture of Quinine, Strychnine, Morphine, and other such, in the present blind state of the healing art, terrible enemies of the human nervous system, is the most desirable of consummations, as their predecessors, the alchemists, are vulgarly supposed to have been possessed with a desire to make gold. It is, I think, devoutly to be hoped, that no one will succeed in making either the medicines or the metal, till we have either ceased to desire them or learned to use them wisely. The worship of drugs, in this generation, is almost as deplorable as its adoration of gold. The one ministers to sham wealth, the other to sham health.

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a dozen or two of different kinds, while the members of the latter might be infinite in number. It must be remembered, however, that, even if this were a correct view of the division here suggested, it would not be so cogent an objection to the scheme as to warrant its rejection; for number of species is no measure whatever of the dignity of a group in natural history; no more so, indeed, than numbers are a measure of human dignity in political condition.

These two divisions of the first Group fairly balanced in point of numbers.

494. But as our knowledge stands at present, the two groups so constituted would be, by no means, so very unequally balanced in point of numbers. It must be remembered that Ammonine [Hydronine], H_3,N, alone, as an epibase, characterizes a far greater number of bases than any other analogous compound. It is probable that some of its thylous homologues follow it pretty closely in this respect, but, at any rate, we do not yet know that any of them attach themselves to all the metallic probases to which their prototype adheres, nor that they ever form with any of those with which they do associate themselves, such a variety of basic systems as are thus generated by Ammonine. With respect to the epibases containing the more complex metabases, we know, at present, very little of them as constituents of bases with metallic probases. They probably enter into many such compounds, but it is not likly that any of them can form a tithe of the number of bases which Ammonine thus generates. The two groups, then, of bases that are

respectively characterized by simple and by complex metabases, as filled by the species known up to the present time, may not very unfairly be compared with each other, even as respects numerical extent. I wish to be understood as suggesting this classification, without stating as my conviction that it is the truest representation of the order of nature.

The second and third Groups subdivided after numbers of Complex and Elementary Metabases, or as these are basic or not.

495. Of the other groups of epibases, and of the correlative bases of the second order, there are none which have all their metabasic places filled by elementary molecules. Their subdivisions will be determined by the numbers of complex and of simple molecules which they contain. Among the second group there is one well-marked set having four elementary, and three complex metabases. It is probable that, in the groups of base having but one antistyle, the metabases are always of basic nature. This is not the case in those basic systems, which contain more than one antistyle, and more than three metabases. The number, therefore, of basic metabases which occur in these other groups of the second order, is an important point in their structure, and on this character, as has been already pointed out,* further subdivisions of these groups may be founded.

The first Group further subdivided: 1. After the numbers of Epibasic Molecules;

496. The first division of the first group of the second order of bases, comprising those of which the epibases have all their metabasic places occupied by single elementary atoms, will diverge into sections

* See § 415, etc. pp. 410 *et seq.*





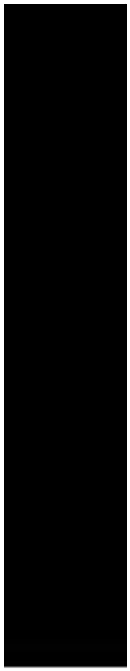


PART IV.

OF SALTS GENERALLY.—CONCLUSION.

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OF SALTS GENERALLY.—CONCLUSION.



CHAPTER I.

OF STYLES AND BASES GENERALLY.

Review. Both parts of salts uniform.

499. Starting from the simple notion of a compound formed of two elementary atoms having a polar relation to each other as respects the voltaic force, we have found the idea of a salt expanding, without loss of the bipolar character, so as to comprehend bodies of an exceedingly complex constitution. This complexity may affect either or both of the halopoles of the salt. We have not been able to discover rules which shall indicate the precise mode in which elements are arranged in every complex basistyle; but we have observed, in the construction of both the main members of salts, a uniformity which may help us, in the greatest number of cases, in our search for this constitution, and may afford us a step towards the discovery of some general laws regulating the formation of salts, and of many other chemical compounds.

Plectostyles analogous to plectobases.

500. We have found that both the various kinds of styles and the various kinds of bases, are marked

by such differences and si
from and unite them wi
groups of each of whi
certain characteristics in
vious distinction that ca
two chemical molecule
between the simplicity o
the complexity of a parti
of atoms. A further s
different degrees and o
plexity. Now there seem
ism between the structu
that of the plectobases.
give a general symmetry
the halopoles of the tw
to arrange themselves in
more particularly mark
each of these two class
part of the scale the res
tion of the members of t
decided and peculiar as t
which it may be worth w
at the cost of some re
recapitulate the observa
the different kinds of ha
tion.

Haplobases more numerous than Haplostyles.

501. Among the styl
there is, in each case, a
guished as being element
composition with their r
gle atoms. These are th

Of the one of these kinds—the haplostyles—there are nine species, to which we apply the term Halogens. These form a well-marked primary class or division among the Elements. Of the others—the haplobases—there are about thirty-six. Of these, one, Hydrogen, stands apart from the others on the ground of the peculiarity of its chemical and physical demeanour; it belongs to a small but primary class of the Elements, which we may call Zoogens. All the other elementary Bases belong to the class of Metals or Geogens. This class of the Elements is divisible into three main groups or orders, one of which is entirely occupied by metallic bases, while there are several basic species in the other two classes.* Thus, the species of the elementary bases are very much more, about four times as numerous, than those of the simple styles.

Autobases more so than Autostyles.

502. Besides the elementary bodies, which act as halopoles, there are some compound molecules which fill respectively the stylic and basic place in salts, and which resemble these simple substances in that they may be isolated in the free condition. Here again, the bases have a great numerical advantage over the styles. We know only two separable plectostyles, only one quite certainly, while a dozen or more complex bases are stated to exist.

* The arrangement to which I here refer, is one not as yet accepted by chemists. It can scarcely be said to have been yet published in full at all, as it has only been propounded to a very small audience in the Royal Institution. But the details and the justification of this mode of classification will, it is hoped, be offered in a published form to the criticism of chemists.

In addition to these latter there are several o
bases, not certainly isolable, but bearing su
general resemblance to those just mentioned
render the expectation of their liberation not
reasonable, while, on the ground of compositi
is difficult to mark them off into a group di
from the former set. We have therefore coll
all these, together with the elementary bases,
the general term autobases, while the name
styles is applied to the known substantive
before mentioned, including the halogens.
group of the autobases may be divided into

Three groups of autobases.

three families:—1. The Elementary Bases. 2
Hypobases. 3. The Synthyles. None of
autobases have a very highly complex stru
Carbon is a constituent of all those that are
plex; Carbon is also a constituent of the
complex autostyles or autostyle hitherto
covered. The smallest proportional quant
which this element enters into either of these
of molecules is that which is represented
symbol C_2.

Constitution of other plectopoles.

503. There are a vast number of plectop
both kinds not included under the two res
heads of the autopoles. Each of these ki
divisible, as we have seen, into two group
each case one of these groups is constitute
numerous collection of molecules, having
definite forms of constitution, while the m
of the other group have not been dissected
to assure us of the manner of the structure

in each of these cases there is a very strong probability that the members of the latter pair of groups are really constituted respectively according to the same plans of organization which are found in the former pair; that is to say, that of these plectopoles, which are not autopoles, all the plectostyles are constituted on a common plan, and also all the plectobases on a common plan.

All are "epipolous."

504. Further, again, it appears that there are not here two plans, but one plan of constitution; for that the type of structure is the same for both these kinds of plectopoles. The complex halopoles stylic and basic, both consist of a primary molecule or propole, with one or more secondary molecules or epipoles attached to it; so that, distinguishing such plectopoles as are thus formed, containing an epipolic constituent, by the epithet "epipolous," we may say that all plectopoles, which are not autopoles, seem to be epipolous in constitution. In the greater number of cases the annexation of an epipole to a propole, on either side of the salt-system, greatly increases the natural polic* energy of the member so strengthened. There is a peculiar tendency in certain of these epipoles, of either kind, to attach themselves in couples to their proper propoles. The energy of the halopoles thus formed with two epipoles is usually much exalted, and the salts which they form with their sympoles are often remarkably stable.

* I would use the word "polic" to mean "belonging to a pole," using the word "polar" in the sense of "having poles."

Analogy in both kinds of ex-epipoles, epipoles, and propoles.

505. Further, in certain species of either kind of halopole a third sort of molecule is superadded to the structure; this we have called an ex-epipole.* Again, the molecules which form the two kinds of propoles, namely the prostyles and the probases, are themselves respectively autopoles of the same denomination with the plectopoles of which they are constituents; the prostyles are of autostylic, and the probases of autobasic capacity. The two sorts of epipoles, too, are constructed on a common plan; both consist of a nuclear molecule, which we call an antipole, united to certain other molecules, which we call metapoles. The epipoles of the stylic side, called epistyles, consist of a nuclear molecule,* an antibase with molecules, metastyles, appended to it; and the epipoles of the basic side, called epibases, consist of a nuclear molecule, an antistyle, with certain molecules, metabases, appended to it. There may be different numbers of metapoles in these epipoles. By far the largest number however of epistyles have three metastyles, and a great many, probably also most of the epibases, have three metabases.

Epipolous plectopoles never isolable.

506. In a vast number of instances the epipoles of both sides are known bodies, which may be separated from the salts; in no one instance is an epipolous plectopole, of either kind, known as a substance.

507. Lastly, there is an analogy between the two kinds of metapoles; they each conform respec-

* See § 94, p. 75, § 387, p. 379.

tively, in chemical capacity, with the propoles, with which they are found associated. The metastyles are always, so far as we know at present, of stylic nature: the metabases are, in a very large number of instances, potentially basic. It is probable that in all epibases, some of the metabasic particles are of basic nature. There is a tendency to the repetition of the same particles in the propolic and metapolic place on either side of the system. It is the general rule that the metastyles repeat the molecule that occurs as the propole: several of the probases favour the annexation to themselves of epibases, whose metabases are a repetition of the probasic molecule. On both sides of the salt-system, these molecules which have the greatest tendency to act as metapoles, are among the weaker of the antipoles. The relations of the ex-epistyles and ex-epibases, both of which are of rare occurrence, are more obscure. It seems, however, that the ex-epistyles are sometimes of epistylic structure and capacity, and the ex-epibases are sometimes of epibasic form; there are certain molecules which can take the ex-epipolic place on either side of the system.*

Propoles are often repeated in the metapoles.

508. Such is the plan of uniformity on which the greater number of complex salts are constructed. There is, however, in nature another principle, besides that of similarity, equally necessary to the development of the perfect beauty of the system of the world; this is the principle of diversity. The

Diversity in the parts of plectohales.

* See § 402, p. 397.

mode in which the requisite differences in structure between the plectobases and the plectostyles, as well as between the various species of each sort of plectopole, are secured, is as remarkable and interesting as the general similarity which marks them all.

Discussion of a typical form of salt.

509. The several parts which we have to consider in the anatomy of these plectohales are these:—Epibases, consisting of metabases and antistyles; probases; prostyles; and epistyles, consisting of metastyles and antibases. It is not necessary here to consider the ex-epipoles, which, not being found in the ordinary compounds, need not occupy our attention in the discussion of the common type. Of these members the metabases, probases, and antibases are of basoid function; the antistyles, prostyles, and metastyles of styloid function. We need not here consider all the varieties of form, which may be produced by the omission, repetition, or multiplication of one or other, or of both of the epipolic members, or by the multiplication of the prohale or endohale to which the epipoles may be attached. It will be sufficient for our present purpose to discuss the archetype of the simplest form of salt, which presents each of the members above mentioned: such a compound is a monohale epibas-epistyle. And of this sort let us select, as being the commonest, the form in which there are three metapoles on either side,—the form which is denoted by the general symbol $\rangle - + - \langle$.

510. Now let us observe the materials which

there are at hand, in the laboratory of nature, for constructing salts of this form. We may then consider what permutations and combinations of these materials are admissible under the archetype, and may understand by what variations the necessary divergence of species may be and is obtained.

511. Firstly, of the stylic side. The prostylic place in compounds of this form can be occupied, so far as we know at present, only by one or other of these following molecules:—six of the nine halogens, viz. Oxygen, Sulphur, Iodine, Bromine, Chlorine, Fluorine. To the same elements the occupation of the metastylic place in compounds of this form is restricted.* No complex molecule occurs in either of these places. The antibasic position may be held in a compound of this form by a considerable number of elements; by the halogens Phosphorus, Sulphur, Selenium, Tellurium, Chlorine, by the geogens Silicon, Boron, Tantalum, Tungsten, Vanadium, Molybdenum, Antimony, Arsenic, Chromium, Manganese, Iron, Gold, and by Sodium among the zoogens. The zoogen Carbon, with its doubled molecule C_2, also takes this place, and a vast number of complex molecules

The stylic.

* I believe that no compounds are described in which the halogen Phosphorus acts as prostyle or metastyle. Selenium and Tellurium probably imitate Sulphur in these functions, but I am not aware that they are known to do so. The autobase Cyanogen is prostylic and metastylic in several stylic systems, but it does not fill three metastylic places in any of its salts, and so does not come under the form we are here considering.

consisting of this element Carbon united with Hydrogen, with the addition of certain other elements in a few instances are found acting as antibases. Oxygen is almost the only molecule that acts as metastyle in the host of epistyles that are generated by these complex antibases.

Elements—generally Oxygen—form epistyles.

512. Here then, it is to be noted, that in these plectostyles there is very little variety admitted in the prostylic and metastylic places; none but elementary molecules, and of these only six different kinds are found in them; and of these six, five occur but rarely, forming thus, perhaps, altogether about a score of different stylic systems. The remaining element Oxygen forms the prostyle and metastyle in hundreds of kinds of salts, filling up by its extensive range of attachments, the wide space left by the reserved tendencies of the few other molecules that imitate it in these functions. The antibasic member, on the other hand, affords the widest scope for variety of structure, and distinction of species. A large number of elementary molecules assume this position, and innumerable complex antibases vie with them in diversifying the characters of the epistylous salts.

Nine metals known as probases.

513. Secondly, of the basic side. The probasic place in compounds of this form can be occupied, so far as we know at present, by the zoogen Hydrogen or by either of the following metals:—Aluminium, Zinc, Cadmium, Copper, Silver, Mercury, Palladium, Platinum, and Iridium.

These metals weakly basic.

514. It is to be observed that this list of metals

which occur as probases in the tri-metabasic epibasistyles, includes none of the stronger bases Only one member, and that an aberrant or hypotypical one, of the order of bases proper, namely, Al', is among them. The others have all basic functions, but not very energetic; three of them, Zinc, Cadmium, and Copper, belong to a second order of metals; the remaining five to a third order. It is probable that some other metals will also be found to act as probases in this system. Certain complex molecules containing Hydrogen and Carbon also occupy this position. We as yet know but few instances of complex probases, scarcely any besides the thylic molecules C_2H_3,—C_4H_5,—$C_{10}H_{11}$. But we have every reason for believing that a very large number of complex carbonous groups may take this position. It is evident, too, that all such molecules will be of basic, but weakly basic function.

Other probasic molecules.

515. The metabasic places may be filled, according to our present information, only by two elements, namely, Hydrogen and Mercury. But the number of complex molecules which enjoy this capacity is very great. We are far from having ascertained the limits of variety of which this part of these epibasistyles admits. We are acquainted with many complex metabases, consisting of Carbon and Hydrogen and with several which also contain Oxygen. Certain halogens also may replace a part of the Hydrogen in these metabases without destroying their function. The epibases, however, of which

Nature of metabases.

these metabases are constituents, lose their characteristic properties when a certain quantity of halogen has been thus introduced into their system. The complex molecules of which we know most, as metabases, are those thyles which we have also seen acting as probases. But we have every reason to believe that the greater of the number of the thyles will be found to imitate their coserials in this tendency. Several other hypobases are known to occur in this position, and there are a vast number of tridactylic epibases of which we have not yet dissected out the metabasic molecules. These, however, when we have detected them, will swell our list of complex metabases to a very considerable length. Variety is further permitted in this part of the structure by the arrangement, that all the metabases may be occupied by molecules different from each other, and from the probase. Nitrogen is almost the only molecule that acts as antistyle in the host of epibases that are generated by these complex metabases. The antistylic position indeed is not known to be occupied by any molecules except one or other of these following elements, namely, the zoogen Nitrogen, the halogen Phosphorus, or the metals Arsenic, Antimony, and perhaps Bismuth, Tin, and Lead. No complex molecule occurs in the antistylic place.

A few elements, generally Nitrogen, form antistyles.

516. Here, then, it is to be noted, that in these plectobases there is very little variety admitted in the antistylic place; none but elementary molecules, and of these only seven different kinds are found

it; and of these seven, six occur but rarely, rming thus, perhaps, altogether about a score of ifferent basic systems. The remaining element N. forms the antistyle in hundreds of kinds of alts, filling up by its extensive range of attachments the wide space left by the reserved tendencies of the few other molecules that imitate it in his function. The probasic and metabasic members, on the other hand, afford the widest scope for variety of structure and distinction of species. A considerable number of elementary and several complex molecules assume the probasic position. Only two elements, however, are known to act as metabases, but innumerable complex metabases vie with each other in diversifying the characters of the epibasious salts.

The variable members of styles and of bases.

517. In the *styles* of this kind, then, diversity is chiefly secured by variation, for which wide scope is afforded by abundance of appropriate materials in the *antibasic member*, which may be complex; while the prostyle and metastyles can only be one or other of a very few simple atoms, and this, in by far the greater number of species, is Oxygen alone. In the *bases* of this kind diversity is chiefly secured by variation, for which wide scope is afforded by abundance of appropriate materials in the *probasic* and *metabasic members*, all of which may be complex, while the antistyle can only be one or other of a very few simple atoms, and this in by far the greater number of species is Nitrogen alone.

Basoid organs being diverse and complex; styloid, uniform and simple.

518. Thus it appears that in epibas-epistyl this form extensive variety is the attribute, and complexity the privilege of the antibasic, the proba and the metabasic organs, that is to say, of all basoid members of the system: while a nar sphere of variety, almost reduced to constancy elementary simplicity, is the condition of the a stylic, the prostylic, and the metastylic org that is to say, of all the styloid members of system.

And this is true generally,

519. Further, in the entire organism of salts of sort, viewed broadly as a mere bipolar arrangen diversity and complexity belong to the idea o basoid, uniformity and comparative simplici the styloid part; for in the former member the entire base, all the metapoles and the pr may be different from each other, and all fo them may be complex; thus allowing the dev ment of molecules of a very high degree of plexity, together with the amplest variabili specific composition. And in the latter me *i.e.* the entire style, all the metapoles and the pole are almost invariably occupied by atoms same element, while only one of the parts antibase, may be complex; thus, both the plexity and the variability of this part o system is comparatively restricted.

and not in tridactylic only,

520. Generally, then, the idea of these doub dactylic epibas-epistyles, diversity and comp belong to the basoid parts, uniformity and si city to the styloid.

31. And the same statement is true, not only of particular kind of salts, but also of all epipolous tohales, not of all particular species, but of all tral forms. The same principle indeed is further ied out in the other varieties of epibas-epistyles. s, there are a far greater number of bases con- ng repeated epibases than there are of styles repeated epistyles. And the multiple epibases ery much more numerous than the multiple yles. Again, in the multiple epibases the iple of diversity is still further applied in the ssion of decidedly non-basic molecules into netabasic places; nothing analogous to this 's on the stylic side of any salts.

but in all epipolous systems,

32. The same law may be predicated of the salt- that is almost the simplest, that is to say, of form which is next in degree of comprehen- ess above that of the haplohales, in which both bers are simple atoms, and which is included ie form to which I now refer,—that of the nales, in which both members are autopoles. only ten or eleven different species of autopoles nown, and of these only one or two are com-

But the autobases are very numerous, and hese there are probably some scores having olex structure.

and true of autohales.

33. But if our hypothesis of the mode of con- tion of these undissected complex halopoles, h are not autopoles,—namely, that they all ain epipoles,—be true, the law which we have enunciated holds good with respect to all

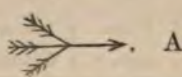
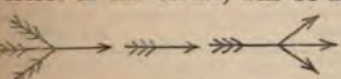
Bases being more divers than styles, in all salts.

forms of salts. For the two sorts of salt form to which I have shown that the law applies, in clude between them—reckoning the forms whic are generated by compounding crosswise the tw members of the two primary forms—all possible sor of single salts. The two original forms are thos of the autobas-autostyles and the epibas-epistyle These, together with the autobas-epistyles and th epibas-autostyles, which are compounded of th members of the former twain, comprehend all po sible monohalic forms. And, since polyhales consi only of monohalic constituents united together, wh is true of all monohales holds good with respect all polyhales. But the same habit is manifested a peculiar manner in multiple salts, so that th statement is specifically true as respects this for of compound. The several bases of multiple sa are different from each other far more frequent than the styles. This is so far the case that multiple salt with its styles diverse is often look upon as an abnormal compound. These tende cies belong therefore to salts simple and compl single and multiple, that is to say to all forms salts whatever.

524. Generally, then, in the most comprehensi idea of the salt diversity and complexity belo to the basoid parts, uniformity and simplicity the styloid.

Diagram to represent this.

525. This notion may be aptly represented our diagrammatic method of general notatio Thus we may conveniently take the feather ⋙

the conventional arrow (⋙⟶) to represent basoid molecules with their variety and complexity, and the head (⟶) to denote the uniformity and simplicity of styloids. Thus our symbol for an autohale, —|—, becomes with his development, ⋙|⟶, expressing an additional feature in the polarity which it typifies. And our diagram of an epistyle, taking for example the tridactylic form, takes instead of —≺ the form  . So also a tridactylic epibase will take instead of ≻— the symbol  . And, for a final example of the saline symmetry, the doubly tridactyle epibas-epibasistyle, which is one of the most perfect of salt-forms, will be denoted by the figure 

526. The relations of the different members of a complex salt of this kind to each other, and to the whole system of which they are constituents, are epitomized in the following Table, in which the constitution of the doubly tridactylic epibas-epistyle is illustrated by the instance of Benzoate of Ethylamylofenylmethyl –‖ "ammonium" [Ethamyfenino-methy-benzite]. This table also exhibits at once the meaning of the anatomical terms which I have used to designate the several parts of the structure of a

Table to show the anatomy of a salt.

Salt.					
Base.				Style.	
Prostylobase.					
		Probasistyle.			
Epibase.		Endobase.		Epistyle.	
Metabases.	Antistyle.	Probase.	Prostyle.	Antibase.	Me
C_4H_3 $C_{10}H_{11}$ $C_{12}H_9$	N.	C_2H_3	O.	$C_{14}H_5$	
Metapoles.	Antipole.	Propole.	Propole.	Antipole.	Me
Basoid.	Styloid.	Basoid.	Styloid.	Basoid.	St
Complex.	Simple.	Complex.	Simple.	Complex.	S
Diverse.	Single.	Diverse.	Uniform.	Single.	U
Variable.	Constant.	Variable.	Constant.	Variable.	C
Isolable.		Isolable.		Isolable	
Isolable?					
		Isolable.			
Not isolable.				Not isolable.	

Division into Orders.

527. From the foregoing observations it wi pear, I think, that the division into orders wh have suggested for those styles and bases whic not autopoles, is, in each case, consistent wit plan of nature. Since, in the comparative anato the epistyles and epibases, the antibase corres to the antistyle, and the metastyles to the bases, it is more in accordance with syste uniformity that if the primary division of the basious styles be made to depend upon the ties of the antibase, that of the antistylous should be governed by those of the anti

When, however, we consider that the principle of diversity is most marked in the basoid members of saline bodies, and that it is in these members only that we have the important alternative of complexity presented to us, it will be seen that if the classification is founded on the simplicity or complexity of the basoid member of the epipole in the one case, the simplicity or complexity of the basoid members of the epipole in the other case, must indicate important divisions of the groups.

528. These, then, seem to be the natural groupings of the kinds of the two sorts of halopoles.

I. STYLES.

Order I. Autostyles. { Family 1. Simple (Halogens). / Family 2. Complex.

Order II. Prostyl-epistyle. { Tribe 1. Styles having single Antibases. / Tribe 2. Styles having complex Antibases.

Order III. Styles containing exepistyles.

II. BASES.

Order 1. Autobases. { Tribe 1. Simple Bases. / Tribe 2. Complex Autobases. { Family 1. Hypobases. / Family 2. Synthyles.

Order 2. Probas-epibases. { Tribe 1. One Antistyle. { Family 1. Metabases simple. / Family 2. Metabases complex. / Tribe 2. Two Antistyles. / Tribe 3. Three Antistyles.

Order 3. Bases containing exepibases.

529. The further subdivisions of the Bases and of the Styles will be recapitulated in the next chapter, in which we shall consider the classification of salts in general. To this latter object, be it remembered, the classification of styles and of bases, which is for the most part hypothetical, is to be subservient.

CHAPTER II.

OF THE DIFFERENT KINDS OF SALTS, AND OF THEIR CLASSIFICATION.

Salts, though innumerable, are readily classified.

530. The species of salts probably exceed in number the kinds of any other group of created things; their variety, indeed, seems to be almost infinite. For they are formed by the combinations of two sorts of materials in sets of pairs; and the numbers of species of these constituent molecules are vastly great, and daily multiplying to our acquaintance, without any hint of a limit to the fecundity of the permutations which produce them. Even if no other bases or styles besides those already known could exist, a description, even a catalogue, of all the separate species of salts that could be formed from them would require a library to contain it. But this inexhaustible abundance of kinds is not so bewildering to the mind as that of the less numerous hosts of forms that issue from the *cornua-copiæ* of our Flora and Fauna. For the forms of construction presented among the salts are comparatively few and simple, and the ultimate elements

of which they are composed, and to which we can refer for helping us to collect them into groups, are but a handful. So that, though it would be a hopeless task to attempt to make a list of the species, it is not so difficult to arrange in the mind a set of co-ordinate groups, amongst which each known species will be referred to its proper place at once, and each new form as soon as its constitution is ascertained.

A general classification

531. I shall endeavour here to sketch a general classification of salts founded on the principles indicated in the preceding pages, without descending to the consideration of species, or even of the smaller groups into which these may be ultimately collected. A mapping out of the longer sections will occupy as much space as is due to the subject in the present place.

primarily founded on bases.

532. The classification of salts may be made to depend chiefly either on their bases, or on their styles. It is more natural and convenient to refer primarily to the bases of these compounds, and to take them for the base of our system, because they are more numerous than the styles, and because to certain of them is mainly due the fixity of our solid earthcrust. Salts, however, are multiple as well as single; and multiple salts frequently have their several bases, or some of them, of different species. In these cases, therefore, there may be a doubt sometimes whether the salts should be classed as related to one of their bases or to another. Generally, however, one of the bases takes the lead in

the compound, in virtue of some marked property of colour, of physical condition, or chemical tendency. This is so often the case that when it does not happen, some arbitrary reason for placing the salt under the head of one or other of its bases may generally be assigned provisionally without infringing the rules of strict method. It seems to me more natural to make the multiple salts constitute subordinate groups under the several primary divisions designated by the bases, than to make the multiplicity or the simplicity of salts their title to be placed in distinct departments of chief dignity.

Subordinate divisions founded on the styles.

533. In the following outline-classification the larger groups of salts are determined by the characters of the bases which the species contain; the smaller groups are made to depend on the styles. The groups are divided and subdivided according to the successively less and less general qualities of the bases, until finally the several species of these bases would be reached, as the characteristic molecules of groups which are still of very great comprehensiveness. These last groups are again to be divided and subdivided according to the successively less and less general qualities of the styles, which may combine with the several bases. Thus, when we have descended in this scale to an expression involving the specific name of any particular molecule, acting as the style of a salt-system, we have reached the lowest grade in the classification, the species of the salt kind. In the outline I have

carried the descending analysis down to the species of the base only in one instance, that of Hydrogen. This elementary base, standing, as it does, quite alone, *sui generis*,—constituting indeed, it may be said, by itself not only its own genus, but its own family and its own order,—is peculiarly adapted for selection as an example of the base-species. Its simpler chemical habit, too, which renders it the ordinary vehicle of the greater number of the styles, fits it admirably for acting as a peg on which the styles may be suspended in order of classification. Under the head, then, of the basic species Hydrogen, I have inserted the continuation of the divisions of the salts, which depends upon the classification of the styles. It must be understood that the same framework of classification belongs to every species of base; so that under the head of every base this array of styles may be understood to be repeated. Every style, however, is not known to unite with every base; it is perhaps certain that many of the styles do not unite at all with several of the bases. These deficiencies would be represented by gaps or zeros inserted in the complete ideal scheme of the classification.

Numerical indication of the kinds of groups.

534. I have not graduated the different groups, as classes, orders, families, etc.; because, firstly, the different kinds of groups are far too numerous for any vocabulary of degrees; and, secondly, because the method of numbering the groups seems to me much more convenient in dealing with so numerous an assemblage of sorts. To each group is

attached a number indicating its station in its
particular rank. In the case of all the gro
below the primary ones, other numbers are p
fixed to the proper ordinal of figure: these in
cate respectively the successive groups of the se
ral superior degrees to which each particular gr
belongs. Thus, " (2,1,2,2,)3. Three complex
tabases," having five figures prefixed to the ver
definition, in which for each figure some wo
are understood to be omitted for sake of brev
means that the group thus designated is the t
group in the fifth degree, of the second group
the fourth degree, of the second in the third
gree, of the first in the second, of the second
the first. By this method the exact place in
scale of every group is ascertained at a gla
without reference to any series of heads and
nominations.

Outline of a Classification of Salts.

535. (The words " Salts having " are to be
derstood as prefixed to the terms descriptive of
bases or of the styles, in the denomination of
group. Thus, " Elementary bases" must be
derstood to mean " Salts having elementary bas
" Prostyl-epistyles" to mean " Salts having pros
epistyles.)

1. Autobases.
(1)1. Elementary bases.
(1,1)1. Zoogen base (H.)
(1,1,1)1. Autostyles.

(1,1,1,1)1. Elementary styles (Halogens).*
(1,1,1,1)2. Complex autostyles (Cy. and Me.?)
(1,1,1)2. Prostyl-epistyles.
(1,1,1,2)1. Elementary antibases.
(1,1,1,2,1)1. Zoogen antibases.
(1,1,1,2,1,1)1. C. as antibase.
(1,1,1,2,1,1,1)1. Two metastyles.
(1,1,1,2,1,1,1,1)1. O. as metastyle.
(1,1,1,2,1,1,1,1)2. S. as metastyle.
(1,1,1,2,1,1)2. N. as antibase.
(1,1,1,2,1,1,2)1. Three metastyles.
(1,1,1,2,1,1,2,1)1. O. as metastyle.
(1,1,1,2,1,1,2)2. Five metastyles.
(1,1,1,2,1)2. Halogen antibases.
(1,1,1,2,1,2)1. P. as antibase.
(1,1,1,2,1,2,1)1. Three metastyles.
(1,1,1,2,1,2,1,1)1. O. as metastyle.
(1,1,1,2,1,2,1)2. Five metastyles.
(1,1,1,2,1,2)2. S. as antibase.
(1,1,1,2,1,2,2)1. Two metastyles.
(1,1,1,2,1,2,2)2. Three metastyles.
(1,1,1,2,1,2,2,2)1. One epistyle.
(1,1,1,2,1,2,2,2,1)1. O. as metastyle.
(1,1,1,2,1,2,2,2)2. Two epistyles.
(1,1,1,2,1,2,2,2,2)1. O. as metastyle.
(1,1,1,2,1,2,2,2,2)2. O. and Cl. as metastyles.
(1,1,1,2,1,2)3. Se. as antibase.
(1,1,1,2,1,2)4. Te. as antibase.
(1,1,1,2,1,2)5. Cl. as antibase.

* I do not here further subdivide this division of the styles, because I purpose discussing the classification of the elements in another work.

(1,1,1,2,1,2,5)1. One metastyle.
(1,1,1,2,1,2,5)2. Three metastyles.
(1,1,1,2,1,2,5)3. Five metastyles.
(1,1,1,2,1,2,5)4. Seven metastyles.
(1,1,1,2,1,2)6. Br. as antibase.
(1,1,1,2,1,2)7. I. as antibase.
(1,1,1,2,1)3. Geogen antibases.*
(1,1,1,2,1,3)1. Si. as antibase.
(1,1,1,2,1,3,1)1. Three metastyles.
(1,1,1,2,1,3,1,1)1. O. as metastyle.
(1,1,1,2,1,3,1,1)2. Fl. as metastyle.
. . . . . .
(1,1,1,2,1,3)x. Cr. as antibase.
. . . . . .
(1,1,1,2,1,3)y. As. as antibase.
(1,1,1,2,1,3,y)1. Three metastyles.
(1,1,1,2,1,3,y,1)1. O. as metastyle.
(1,1,1,2,1,3,y,1)2. S. as metastyle.
(1,1,1,2,1,3,y)2. Five metastyles.
(1,1,1,2,1,3,y,2)1. O. as metastyle.
(1,1,1,2,1,3,y,2)2. S. as metastyle.
. . . . . .
(1,1,1,2,1,3)z. Pt. as antibase.
(1,1,1,2,1,3,z)1. One metastyle.
(1,1,1,2,1,3,z,1)1. O. as metastyle.
(1,1,1,2,1,3,z,1)2. S. as metastyle.
(1,1,1,2,1,3,z,1)3. Cl. as metastyle.
. . . . . .

* Under the head of "Salts having Geogen Antibas
give only a few instances as examples of the method of cl
cation; because I cannot carry out the analysis without ent
more minutely into the classification of the elements
would accord with the plan of the present work.

(1,1,1,2,1,3,*z*)2. Two metastyles.
(1,1,1,2,1,3,*z*,2)1. O. as metastyle.
(1,1,1,2,1,3,*z*,2)2. S. as metastyle.
(1,1,1,2,1,3,*z*,2)3. I. as metastyle.
(1,1,1,2,1,3,*z*,2)4. Br. as metastyle.
(1,1,1,2,1,3,*z*,2)5. Cl. as metastyle.
(1,1,1,2,1,3,*z*,2)6. Fl. as metastyle.

. . . . . .

(1,1,1,2,1,3), etc. etc. Other geogens as antibases.

. . . . . .

(1,1,1,2)2. Complex antibases.
(1,1,1,2,2)1. Autostylic complex antibase (Cy.).
(1,1,1,2,2,1)1. One metastyle.
(1,1,1,2,2,1,1)1. O. as metastyle.
(1,1,1,2,2,1,1)2. S. as metastyle.
(1,1,1,2,2)2. C. as antibase.
(1,1,1,2,2,2)1. C_2 as antibase.*
(1,1,1,2,2,2)2. C_3 as antibase.†
(1,1,1,2,2,2)3. C_4 as antibase.‡
(1,1,1,2,2,2)4. C_5 as antibase.§
(1,1,1,2,2)3. C_mH_n— nuclei‖ as antibases.
(1,1,1,2,2,3)1. Nuclei of form $C_2H(C_2H_2)_n$, N. as antibases.
(1,1,1,2,2,3,1)1. C_2H— nucleus as antibase.
(1,1,1,2,2,3,1)2. C_4H_3— nucleus as antibase.
(1,1,1,2,2,3,1,2)1. C_4H_3 as antibase.

H:O;C_2,O_3, Oxalic [Xaliric or Dicarbiric] acid.
(H:O)$_2$;C_3,O_4, Mesoxalic [Tricarboric] acid.
H:O;C_4,O_3, Mellitic [Tetracarbiric] acid.
H:O;C_5,O_4, Croconic [Pentecarboric] acid.

By a C_mH_n-nucleus, I mean any such molecule as is either tual hydrocarbon, or is known to be derived from a hydro- n by definite substitution of another molecule for a con- nt part of a hydrocarbon.

(1,1,1,2,2,3,3,1,2)3. $C_{12}Cl_5$ as antibase.
(1,1,1,2,2,3,3,1)3. $C_{12}H_{5-n}(NO_4)_n$ as antibases.
(1,1,1,2,2,3,3,1,3)1. $C_{12}H_3(NO_4)_2$ as antibase.
(1,1,1,2,2,3,3,1,3)2. $C_{12}H_2(NO_4)_3$ as antibase.

. . . . . .

(1,1,1,2,2,3), etc. etc. C_nH_n — nuclei of other forms, as antibases.

. . . . . .

(1,1,1,2,2)4. $C_nH_nO_r$ — nuclei as antibases
(1,1,1,2,2,4)1. Nuclei of form $C_2H(C_2H_2)_nO_2$ as antibases.
(1,1,1,2,2,4,1)1. $C_4H_3O_2$ as antibase.
(1,1,1,2,2,4,1)2. $C_6H_5O_2$ as antibase.

. . . . . .

(1,1,1,2,2,4)2. Nuclei of form $C_{10}H(C_2H_2)_nO_2$ as antibases.
(1,1,1,2,2,4,2)1. $C_{14}H_5O_2$ — nucleus as antibase.
(1,1,1,2,2,4,2,1)1. $C_{14}H_5O_2$ as antibase.
(1,1,1,2,2,4,2,1,1)1. One metastyle.
(1,1,1,2,2,4,2,1,1)2. Three metastyles.
(1,1,1,2,2,4,2,1)2. $C_{14}H_4(NO_4)O_2$ as antibase.
(1,1,1,2,2,4,2)2. $C_{16}H_7O_2$ — nucleus as antibase.

. . . . . .

(1,1,1,2,2)5. Nuclei containing N. as antibases.*

* The anatomy of the salts of this group is for the most part ther obscure, I therefore do not venture to do more than indite the group.

(1,1,1,2,2,5)1. C_3N_2H as antibase?*

. . . . . .

(1,1,1,2,2)6. Nuclei containing geogens as antibases.

(1,1,1,2,2,6)1. C_4H_6As, as antibase.

. . . . . .

(1,1,1)3. Prostyl-epistyl-exepistyles.

(1,1,1,3)1. Exepistyles of epistylic form.

(1,1,1,3,1)1. One exepistyle.

(1,1,1,3,1)2. Two exepistyles.

(1,1,1,3)2. Exepistyles of epibasoid form.

(1,1,1,3,2)1. One exepistyle.

(1,1,1,3,2)2. Two exepistyles.

(1,1,1,3)3. Exepistyle of neutral form.

(1,1,1,3,3)1. Exepistyle an independent adjunct.

(1,1,1,3,3)2. Exepistyle derived from the epistyle by substitution.

. . . . . .

. . . . . .

(1,1)2. Geogen bases.†

(1)2. Complex autobases.

(1,2)1. Hypobases.

(1,2,1)1. Thyloids, C_nH_n— nuclei.‡

(1,2,1,1)1. Thyles, $H(C_2H_2)_n$— nuclei.

(1,2,1,1)2. Fenyloids, $C_6H(C_2H_2)_n$— nuclei.

* Uric acid ($H:O;C_5N_2H,O_3$—?).

† I do not here consider the divisions of the Geogens or metallic bases, because I have discussed the classification of the metals at length in the work on the chemical elements just now alluded to in a note. It does not accord with my plan of the present work, further to anticipate the subject of the other.

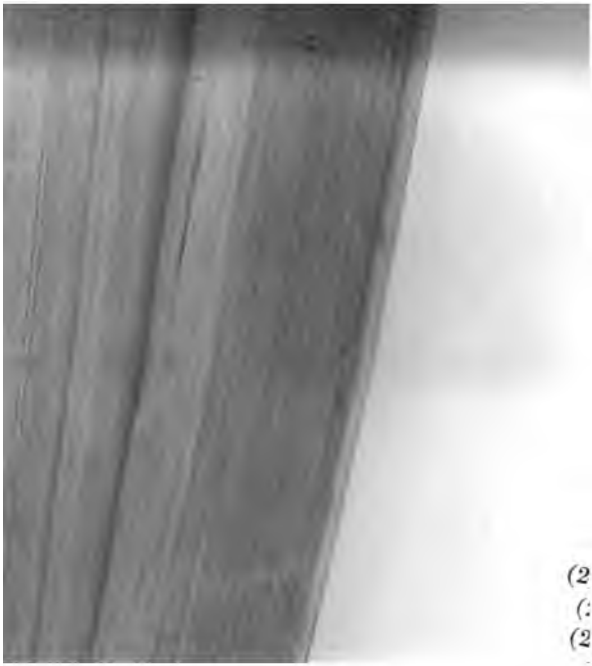
‡ See note ‡, p. 107.

(1,2,1,1)3, etc. Other C_mH_n— nuclei.
(1,2,1)2. Nuclei containing halogens (O. and perhaps S.).
(1,2,1,2)1. $C_mH_nO_r$— nuclei.

. . . . . .

(1,2)2. Synthyles.
(1,2,2)1. Metallothyles.
(1,2,2,1)1. One molecule of metal with one molecule of thyle.
(1,2,2,1)2. One m. of metal with 2 m. thyle.
(1,2,2,1)3. One m. metal, more than 2 m. thyle.
(1,2,2,1)4. More than one molecule of metal.
(1,2,2)2. Mefitithyles.

Probas-epibases.
(2)1. Epibases with one antistyle.
(2,1)1. N. as antistyle.
(2,1,1)1. Elementary metabases.
(2,1,1,1)1. Hg. as metabase.
(2,1,1,1)2. Hg.' as metabase.
(2,1,1,1)3. H. as metabase.
(2,1,1,1,3)1. H. as probase.
(2,1,1,1,3)2. Geogens as probases.
(2,1,1,1,3,2)1. One epibase.
(2,1,1,1,3,2)2. Two epibases.
(2,1,1,1,3,2)3. Three epibases.
(2,1,1,1,3,2)4. Four epibases.
(2,1,1)2. Complex metabases.
(2,1,1,2)1. C_mH_n— nuclei as metabases.
(2,1,1,2,1)1. One complex metabase (and two elementary metabases).
(2,1,1,2,1,1)1. $H(C_2H_2)_n$— nuclei as metabase.
(2,1,1,2,1,1)2. $C_8H(C_2H_2)_n$— nuclei as metabase.



(2,1)3. Geogens as antistyles.
(2,1,3)1. Sb. as antistyle.
(2,1,3)2. As. as antistyle.
(2,1,3)3, etc. Other geogens as antistyles.

. . . . . .

(2)2. Epibases with two antistyles.
(2,2)1. N. as antistyle.
(2,2,1)1. Five basic metabases (and one non-basic metabase).
(2,2,1)2. Four basic metabases (and two non-basic metabases).
(2,2,1,2)1. C. O. as two metabases.
(2,2,1,2,1)1. Four H. metabases.
(2,2,1,2,1,1)1. H. as probase.
(2,2,1,2,1,1)2. Geogens as probases.
(2,2,1,2,1)2. One complex basic metabase (and three H. metabases).
(2,2,1,2,1)3. Two complex basic metabases (and two H. metabases).
(2,2,1,2,1)4. Three complex basic metabases (and one H. metabase).
(2,2,1,2,1)5. Four complex basic metabases.
(2,2,1,2)2. C_2N as two metabases.
(2)3. Epibases with three antistyles.

. . . . . .

3. Probas-epibas-exepibases.
(3)1. Exepibases of epibasic form.
(3)2, etc. Exepibases of other forms, etc.

---

536. A great number of the forms indicated in the above sketch are further modified by the occurrence of multiple salts, which are to be referred Multiple salts.

generally to the head o
in the multiple system.

Their classification.

537. Multiple salts a
ferences depend on—

1. The degree of thei
2. The manner of th

538. The first modi
double, triple, quadrupl

539. The second mo
divide them, according
have their

(1.) Bases different,
(2.) Bases similar, st
(3.) Bases different a

540. Some of the mu
poles are also modified
of their members. Th
forms:—

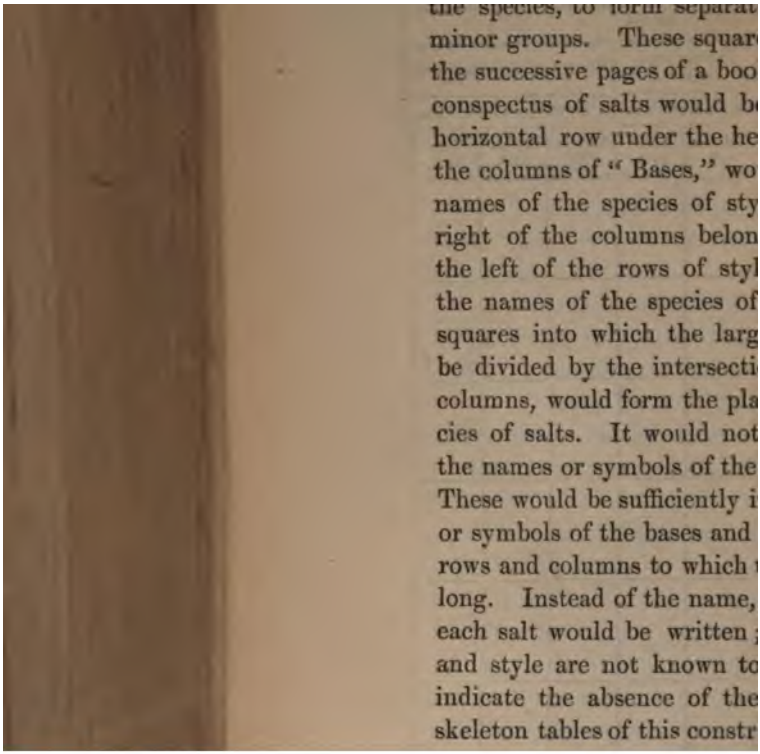
1. One epibase attac
2. Two epibases
3. Three ,,
4. One epibase
5. ,, ,,
6. ,, epistyle
7. Two epistyles
8. One epistyle
9. ,, ,,

Tabular method of registering salts.

541. It is obvious tha
salts would be represen
manner by a square or
opposite sides should b
lengths corresponding t

ses, while the other sides would be divided accord-
g to the groups and species of styles. Thus :—

sification of Salts.			Styles.						
			Autostyles.		Prostyl-epistyles.		Prostyl-epistyl-exepistyle.		
			Halogens.	Complex Autostyles.	With Antibases.		With Exepistyles in form.		
					Elementary.	Complex.	Epistyloid.	Epibasoid.	Neutral.
Probas-epibas-exepibases.	With epibases in form.	Styloid.							
		Epibasoid.							
Probas-epibases.	With Antistyles.	Three.							
		Two.							
		One.							
Autobases.	Complex.								
	Elementary.								



APPENDIX.



APPENDIX.

On a Method of Nomenclature for Chemical Compounds, adapted to assist the memory in retaining their composition.

In the course of the preceding pages, I have endeavoured to show, suggestively, how by modifying the current names of numerous compounds according to principles already recognized in the accepted nomenclature, a set of names may be produced which present conveniences not belonging to the terms now in use. These advantages are, first, that the proposed words denote, by their generic similarities, certain important properties which are respectively common to several groups of compounds, and so indicate the kind to which each species belongs; second, that each term records the composition of the body to which it is attached, and so distinguishes each species from its kindred. I have endeavoured, in the formation of these words, to depart as little as possible from the received fashion, so that there may be as much resemblance between the new appellations and the old, as is consistent with a uniformity of method. The system thus

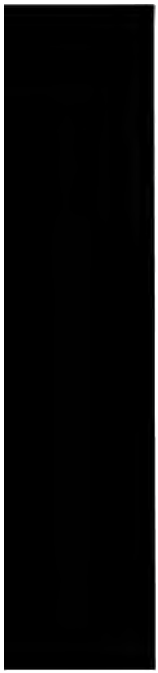
it is less obvious and less easily demonstrable, therefore, in many cases, less certain, than the o two qualities—composition and function. Again, t two latter are, in by far the greater number of c sufficient for the determination of the species o substance. In fact, it is only in some of the co ratively rare instances in which the same compos is common to two or more bodies that the state of their constitution is necessary to the definiti their difference from each other. In the greater ber of such cases of isomerism, though the com tion is the same, there is a difference in functio that the statement of these two attributes is suff to indicate at once both their relationship and dissimilarity. It is only where both compositio function are repeated, that the third quality is sary to mark the distinction. Thus, "Aniline" "Picoline" have both the composition $C_{12}H_7N$ both are epibases: so that a name which might e only these facts, being common to both, would b biguous. In such cases we require either the essential—that of constitution—to be denot some arbitrary symbol to be introduced, so as to the difference of the two species. But these c dences are scarce, in comparison to the vast nu of compounds, which may be distinguished from other by marking their elementary compositio their chemical potency.

Leaving, then, generally, the constitution of che compounds to be expressed in their formulæ, I found for them on their two other characters— position and function—a scheme of nomenclatu rather, I would say, of phonetic notation, which

provide for each a brief written and pronounceable symbol. If such a set of symbols or words are short, not cacophonic, and easily remembered, and if they actually state, according to a simple law, the fundamental peculiarities of each chemical species, they will, I think, be valuable, if not as currency for the regular exchange of scientific communication, yet for private use as an aid to the memory. With this view I offer the following plan to my fellow-students. I do not claim any originality or novelty for it; but neither did I construct it as an improvement upon any other similar scheme. It occurred to me one day, exactly as I now present it to the reader, some years ago, long before I had heard of Gmelin's "suggestions for a new chemical nomenclature."* The system which I here offer to the student is certainly similar to that of the great German authority in principle, and in one most essential point, that of the vowel symbols for the numbers of atoms in the compounds. This notion, however, I owe not to Gmelin, but to the admirable little English book, Grey's 'Memoria Technica,'† in which this method of arithmetical notation was long ago applied to chronology chiefly, but also to almost every branch of knowledge except chemistry. I think that the form which I propose is somewhat simpler and easier to learn than that of Gmelin, and that the names evolved from it will be somewhat more euphonic than the specimens given, in the 'Handbook,' of his new nomenclature.

* Gmelin's 'Handbook of Chemistry,' Watts's Eng. tr., vii. p. 149.

† Dr. R. Grey's 'Memoria Technica, or Method of Artificial Memory.' New ed.; Oxford, 1831.



symbols are at present consu
ments now recognized, only
vowel symbols. Ac, E, I, O, U
bols consisting of a vowel fo
Ag, Al, As, Ir, Os. 21 of the
are made of a consonant follo
Bi, Ca, Ce, Co, Cu, Fe, La, I
Br, Se, Si, Ta, Te, Ti. The ot
of consonants. But of these
sound: and S of them, Cd, M
Th, are not distinctly pronoun
(that is, as followed, but not
except perhaps by a few natio
in utterance than in chemist
are consonantal forms, which c
initials more or less easily by
these. 14 represent simple cons
F, H, K, N, P, R, S, Th,* W
9. Br, Cl, Cr, Sb, Sn, Sr, Zn,
afford us a sufficient precedent
dify the series in one or two p

Now it is evident that, if we always take a particular consonant to represent each element, and a vowel to represent the number of atoms of each element contained in any given compound, we shall have the name and quantity of each such component represented by a single syllable, and a word composed of such syllables will exactly denote the composition of the body. We should thus arrive at a language constructed like the "polysynthetic" tongues of America, and if well put together, it ought to be as fluent as the beautiful Guarani of Paraguay. If we adhere to the rule that consonants shall always mean elements, and that vowels shall always stand for numbers, each vowel always belonging to the consonant which immediately precedes it, there can never be the least doubt about the meaning of all our syllables, and of every word composed of them. For every such word would express one definite composition and no other. This then is the basis of my plan: but it requires to be slightly modified; for these reasons. We have not 62 simple consonant sounds. In the English language, which is nearly the richest in sounds, quite the richest in consonants, of all the polished languages of western Europe, there are 21 simple consonants, which may be, and of which all, with one exception, are used in English, as initials of syllables.* We may, however,

* I use the term consonant in a general sense, to include all spoken sounds which are not of vowel kind. For a true analysis of human speech, I beg to refer the reader to the admirable 'Essentials of Fonetics,' by A. J. Ellis (London, 1848), especially to the alphabets at pp. 58, 126. Our twenty-one initial simple consonants are the first sounds of these words: *yea*, *way*, *hay*, *roll*, *lull*, *mole*, *no*, *pole*, *bowl*, *toe*, *doe*, *came*, *game*, *fear*,

increase the number of ava
a great extent, by combini
mit of being paired, into d
nants. Now we must be
among these materials by t
We ought as far as possi
symbols, and, where this is
each element, a letter or
its ordinary name. We ou
construct a universal lang
which are not pronounce

veer, *thigh*, *thy*, *seal*, *zeal*, *shall*,
word "vision." This last soun
guese represent by *j*, is not us
our language, though it occurs
the instance given, and we have
at the commencement of a wo
single consonants, one, the final
not accord, as an initial, with
and the other, the final of "fair
Perhaps the reader requires to
not really, as it should be and
is, a complete code of symbols
four simple consonants, which
symbols, *ng*, *sh*, and *th*, whereo
Again, we have three consonant
the purposes of two,—*c*, which
function; *g*, which also does du
y, which takes also the work
and we have three single letters
sounds: *q*, which is substituted
and *j*, which combines *d* with t
no special place of its own, but
for our vowels, each of them d
rage; we have at least fourtee
diphthongs, and only five prope

most civilized countries, and which are not all clearly and universally distinguishable from each other in pronunciation. Generally, where there is a choice of sounds, whereof one is easier or simpler in speech than another, and of elements, whereof one is more commonly met with than another, we should give the preference to the simpler symbol for application to the commoner element. We ought not unnecessarily to double letters, because it may be very convenient to have as many as possible of these compound symbols in reserve for the purpose of expressing certain compound molecules, which often enter into composition in the same manner as do the elements. By adopting this latter principle, we may, in the cases of some complex bodies, abbreviate their names, which would be longer than most of our new words; and again, we may sometimes introduce a notion of the constitution of a compound, so as to distinguish it from another that is isomeric with it.

First, then, let us select our vocal symbols of the elements in accordance with these considerations. We may take the list of English consonants as the basis of our system, because it comprises nearly all those of the other nations that are great in Christendom, and in Chemistry, and adds to them no sound which it is not desirable that all the world should learn to use. The only European sounds we shall thus exclude are the gutturals of the Germans, and—though we can scarcely mention them as great on either ground—of the Spaniards. We may omit these sounds on account of their indistinctness, and liability to confusion with the aspirate H; and because there is neither any element that specially demands either

of them as its symbol; nor any Roman letter which either of them can claim as its appropriate character. The only additional sounds we shall present to the Frenchman or the German are those which we represent by *th*, by *j*, and by *w*.

Before we discuss our symbolic sounds, we must determine the characters which, in turn, are to symbolize them to the reader's eye. We must make our written language strictly phonetic, or it will be useless to us; each letter must represent one simple sound, and one only, and every simple sound must have its own one peculiar character. On these same principles it will be desirable not to represent any double consonants by single letters, but in each case to write for them the characters of the simple sounds of which they are composed. We have then 22 simple initial consonantal sounds. And our alphabet supplies us with 21 consonant characters. The two lists, however, do not correspond throughout their series. But there will be little question as to the import of these following 14 of our letters, B, D, F, H, L, M, N, P, R, S T, V, Y,* Z. We need only remember that our German friends will be always pronouncing Z as Ts, so that for their sake, to avoid confusion, we must not introduce Ts among our double symbols. The following 7 letters remain to be appropriated, C, G, J, K Q, W, X. Let us agree, at once, that C and G shall always have the meaning which is attached to them in our words *C*ame, *G*ame, never encroaching on the pro

* Let no Englishman, who spells his affirmation "yes," and addresses his neighbour with "you," allow that *y* has any claims to be considered a vowel-symbol. For him "yttrium," if it is to be pronounceable, should become "yitrium."

vinces of S and J. Let us give to J the French signification as fixed by the word "je;" for the sound of the second syllable of our word "vision." This is but fair; for its German usage is filled by our Y, and we apply it to a double letter (dj), which our rule will not allow it to retain. Let us ask to have W in our national sense; and there remain K, Q, X, still free. We have also the initial consonants of the words "Thy," "Thigh," "Shall," unrepresented. We may either retain our old fantastic "Sh," or follow the Portuguese fashion, in representing it by X, or, with Mr. Ellis, we may borrow the Greek Σ for it. We may agree to reject one or the other of the two "Th's," or to have but one character for them, as we shall require but one of them. K and Q are not fitted by their habits for this usage, and are not wanted for any other. Let us then here either admit another irregular use of "h," retaining the "Th," or let us put the Greek Θ in the place of this double symbol.

We have now this fundamental alphabet of 20 letters, from which to select and construct our elemental characters:—M, N, L, R; B, P, F, V; D, T, Th or Θ; C, G; S, Z, Sh or X or Σ; J, H, W, Y. We need not now to speak any more of sounds as distinct from letters, but may use these letters as the written names of the sounds to which respectively we have assigned them.

Of this list we find the following 13 already attached to certain elements, N, R, B, P, F, V, D, Th or Θ; C, S; H, W, Y. These I would leave untouched, with three exceptions. K, which is the only other simple consonant letter, now serving as a symbol, and which is accepted for Potassium, is excluded from our alpha-



letter: F is its true initial; i
far as concerns its consonan
then devote F to Fosforus,
which it naturally belongs.
from Rhodium, which, from i
use for so serviceable a letter.
this symbol to Oxygen: maki
rule of deriving the symbols
ments, for these reasons. Thi
a number of compounds, that
in the mouth of the chemist.
desirable to represent it by a
and the more particularly so, a
making I have to propose, t
most frequently come at the e
compound in which that elemer
is particularly requisite in t
name Oxygen suggests (*x*, th
consonantal representative of
of terminal syllables involving
be intolerable. Of its other
N, the one is already appropr
other will be required for anot

ner 10 of these simple consonants will retain their
ual significations.

We have now the following 7 simple consonants
ailable as symbols, M, L; T; G; Z, Sh X or Σ;

We may very conveniently substitute M, L, T,
for the Mg, Li, Ti, Zn, of the usual catalogue. G
too distinct and vulgar a letter to be omitted from
r alphabet. We may fairly apply it to Gold, for
ich it is claimed as its initial by two out of the three
ropean chemical tongues; the French initial O,
ng, like the accepted Latin Au, as a vowel, inad-
ssible. J may be applied, as a substitute for the
uble sound Zr, which is more difficult to pronounce
an initial, and which may be mistaken for Sr, which
shall require for use; this change is justified by
e French usage of "jacinthe," as the name for one
the forms of gem in which Zirconium is presented
us in nature.* The sound which has been repre-
ted by Sh X or Σ, does not occur in the name of
y of the elements, nor is there any for which it sug-
sts itself as an appropriate symbol.

We have now exhausted our single consonants upon
of the elements, not quite one-third of their num-
r. We can proceed no further without doubling
r phonetic symbols. The only combinations of con-
nants which our vocal organs permit us to make
th facility at the beginning of words, are these,
ich are thus made. We may add the liquids L or

* As we shall not want the double letter *dj* (the English *j*), any other application, it will be open to any one who prefers o give this sound to the symbol of Zirconium; an English- n may derive it, for conformity, from the Jargon, an old name the Zircon.

R, after any of the other consonants except M, H, W, Y, which do not amalgamate with them civilized tongues, and Z, whose union with R we h just now declined. We may easily prefix S to an our simple consonants, except Z, Sh or X or Σ, J, H, and to any double ones, except such as comm with these letters. Z also may be prefixed to a other consonants, but these combinations are always clearly distinguishable from the similar c pounds of S. S and Z may also follow other co nants, but not neatly.

Of the double consonants, which are thus ope us, we find these six examples in the current catal Br, Cl, Cr, Sb, Sn, Sr. These we retain, of cou adding to them the old Gl, for Glucinum, as a r substitute for the Be, which has of late years planted it. Fl, too, which is often used to repr Fluorine, may be kept for that service, instead o F, which we have transferred to Fosforus. The lowing substitutions will also appear easy and nat Dr for the Hg of Hydrargyrum, Bl for the C Cobalt, Pl for Pb, Fr for Fe, Sl for Se, Tl for T for Tb, Sc for Si, when we consider the spelling o names of the elements respectively denoted by t symbols. Pr may be substituted for the Cu of prum. And Osmium suggests *Sm* instead of its i missible Os; and from Sodium we may derive S replace Na. None of the other elements offers u its name, any suggestion for another double in consonant, to be added to this second set of 19.

We must find some other mode of supplying remaining 24 elements with symbols that will monize with our phonetic system. Now we h

agreed that a vowel shall have no meaning in our words, except in connection with the consonant which precedes it. If, then, we commence a word with a vowel, such a sound will not at all affect the significance of the term. Now we may construct a very large number of double consonants which can be pronounced with a vowel preceding them. Some of these can be used as the final sounds of words, others can only be pronounced with another vowel following them. For our purpose, however, we need draw no distinction between the two kinds of sounds, as we shall not require any of them at the ends of our words, as symbols of the elements: since these are always to be followed by a numeral vowel. We may then take the remaining elements in turn, and select, for each, a consonant of this sort, as its symbol. And we may arrange that, when such symbol is the first of a set which are to form a compound word, it shall be preceded by an auxiliary vowel, such as any short vowel from one of the English words "bat," "bet," "bit," "but," "hot," or "her," that may be convenient, from association with the usual name of the element, or from facility of pronunciation. When such consonant occurs not at the beginning of a word, the numeral vowel of the preceding syllable will be sufficient to lead on the consonant, without any adventitious aid. Among the old symbols we have still remaining under this head, these four, which we may retain with their usual significations, *cd*, *mn*, *nb*, *pt*, which latter some persons may perhaps pronounce as an initial. And we may then make the following substitutions, which are all obviously suggested by the spelling of the current names of the elements:—*lm*

which we have transferred fro

The consonantal alphabet of
we have thus constructed, is
lowing tables. In the first of
elements are placed according
initial letters in the ordinary
the second the new symbols
their relations to the same
arrangement will enable an
memory of any symbol at an
glance at one or other of thes
that 22 of them, more than
number, are the old symbols i
tions, and 26 others retain on
the old symbols. Those symb
initials, are each marked by a

Names and Consonantal Sy

Aluminum .	lm	Chlorine .	
Antimony .	Sb	Chromium	
Arsenic . .	rs	Cobalt . .	
Barium	bm	Copper	

Nitrogen. . N	Ruthenium. rt	Thorium . . Th
Norium . . nr	Selenium. . Sl	Tin . . . . . Sn
Osmium . . sm	Silicium . . Sc	Titanium . T
Oxygen . . R	Silver . . . rg	Tungsten. W
Palladium . ld	Sodium . . sd	Uranium . . rn
Pelopium . lp	Strontium . Sr	Vanadium . V
Phosphorus F	Sulfur . . . S	Yttrium . . Y
Platinum . pt	Tantalum . nt	Zinc . . . . Z
Potassium . P	Tellurium . Tl	Zirconium . J
Rhodium. . rm	Terbium . . Tr	

Phonetic Symbols and Names of the Elements.

B . . Boron	lb Molybdenum	rm . Rhodium
Bl. . Cobalt	lc . . Calcium	rn . . Uranium
bm . Barium	ld . . Palladium	rs . . Arsenic
Br. . Bromine	lm . Aluminum	rt . Ruthenium
bs. . Bismuth	ln. .Lanthanum	S . . Sulfur
C . . Carbon	lp . . Pelopium	Sb . Antimony
cd. . Cadmium	M . Magnesium	Sc . Silicium
Cl. . Chlorine	mn . Manganese	Sd . Sodium
cm . Cerium	N . . Nitrogen	Sl . . Selenium
Cr . Chromium	nb. . Niobium	Sm . Osmium
D . . Didymium	nc. . Nickel	Sn . Tin
dn . Iodine	nr. . Norium	Sr . Strontium
Dr . Mercury	nt. . Tantalum	T . . Titanium
F . . Fosforus	P . . Potassium	Th . Thorium
Fl . Fluorine	Pl . Lead	Tl. . Tellurium
Fr . Iron	pt. . Platinum	Tr . Terbium
G . . Gold	Pr . Copper	W . Tungsten
Gl . Glucinum	R . . Oxygen	V . . Vanadium
H . . Hydrogen	rb. . Erbium	Y . . Yttrium
J . . Zirconium	rd. . Iridium	Z . . Zinc
L . . Lithium	rg. . Silver	

In the cases of ditimious metals, which enter into composition with two different equivalent weights, we

may distinguish the two stat
an "s" or other consonant
indicate the secondary com
Fe=fr, Fe′=Fe$_{\frac{1}{2}}$=sfr. Pt′=
Ir$_{\frac{1}{2}}$=srd. Co=bl, Co′=Co$_{\frac{1}{2}}$

We have now to determin
the numbers, which are to
compound bodies. It is e
make such a selection as
general utility; for the sev
differ much more in their v
nants. The decimal notati
lowed; ten vowels will there
sent the ten numeral digits.
to select ten vowels which s
to Englishman, German, a
however be sufficient if the
that even though the pronu
should not coincide in their
there should be no danger o
vowel sound of one symbol

It will be convenient, un
the case, to determine our s
assign to them their phonet
five vowel characters in the
namely, a, e, i, o, u.* Now,
the number which we requi
until we shall be allowed to
those of Mr. Ellis's beautif
other five characters by the
such as a dash-line over each
we shall have the ten arithn
by vowel symbols, thus:—

* See note to

1	2	3	4	5	6	7	8	9	0
a	e	i	o	u	ā	ē	ī	ō	ū

We have now to consider what sounds we shall assign to these characters. There can, I think, be no doubt about the import to be attached to the first five. The English usage is to be rejected not only for its irregularity, but because it is, in four points out of the five, generally at variance with the practice of every other nation that uses these letters, and also because it normally attributes to *i* the value of a diphthong. We ought clearly to have only single sounds for our most elementary symbols, reserving compound vowels for higher numbers. We will take these primary vowels, then, to denote five of the vowel sounds to which they are applied by the consent of Europe. But in the orthography of most languages each of these characters represent at least two sounds, a long and short one. In French, as in English, the use of these vowels is very variable, not only in length, but in quality. We do not, however, require exact precision of use for each vowel. It will be sufficient for our purpose if we can indicate such values as can always be given to our symbols approximately, and without confusion of one with another. We may then give to these letters respectively such values as belong to the several vowels in the following words:—

Examples.

Vowels.	English.	German.	French.
a	*a*lms	d*a*	p*as*
e	*a*le	*e*sel	n*ée*
i	*ee*l	*i*hn	f*ille*
o	*o*pe	*o*hne	*eau*
u	f*oo*d	d*u*	*où*.

In the 'Memoria Technica' of Grey, the signs put for the digits 6, 7, 8, 9, 0 are *au*, *oi*, *ei*, *ou*, *y*, with the phonetic value which they have in the English words 'p*au*se,' 'b*oi*l,' '*ei*ther,' 'n*ou*n,' 'ver*y*.' In the system of nomenclature proposed by Gmelin, these figures are represented by the characters *ai*, *äu*, *au*, *ö*, *ü*, representing the sounds to which those symbols belong in the German orthography. We cannot adopt either of these sets of symbols, or either of the series of sounds which they represent. For the doubled vowel signs would cause confusion, as we shall want these for numbers higher than 10; and in each series there are sounds which are peculiar to one language or the other. From them, however, we may select these sounds, which are common to English, German, and French, as marked by the following examples, denoting them by the symbols prefixed to each example:—

Examples.

Vowels.	English.	German.	French.
ī	*ai*sle	*ei*le	pa*ï*en
ō	*ow*l	f*au*l	*août*
ū	f*ï*n	*i*nnige	f*ini*.

We may complete the list in English with the two following vowel-sounds:—

ā = *a*ll
ē = *oi*l.

For these, in German or French pronunciation, may be substituted,—

ā	d*er*	f*ait*
ē	Goethe	je*û*ne,

or any other two sounds not liable to be confounded with any of our others.*

* The five last of our numeral symbols may also be rendered

have selected a series of long vowels, preferring to
compelled to introduce among them some diph-

e five short sounds of the following words :—

Vowels.	English.	German.	French.
ă	b*a*t	d*a*nn	p*a*tte
ĕ	b*e*t	d*e*nn	cad*e*tte
ĭ	b*i*t	*i*nnige	f*i*ni
ŏ	h*o*t	v*o*n	h*o*mme
ŭ	h*u*t	k*u*nst	h*u*tte

is an objection to this arrangement, namely, that it is lt to pronounce two short vowels successively, extremely lt to pronounce three. But in practice this obstacle will pear, for until we have compounds with more than five red and ninety-nine atoms of the same element, we shall have three short vowels coming together. We shall never two short vowels in sequence, except in cases where there ore than fifty atoms of one element, and in only half of small number; for one-half of such rare compounds will, probability, have a figure less than six in the unit-place e index number of their Carbon or Hydrogen, which are nly elements which are likely to be so multiplied. And ever two short vowels do concur, an *x* or *σ* (Greek) (*sh*) e placed between them, which removes all the difficulty of utterance; this same sound may also be introduced occa-lly between the units and the tens when one only of these be denoted by a short vowel.

ain, any Englishman who wishes to have a decimal vowel for home use only, may take the vowel sounds of his eight ardinal numbers, 'one,' 'two,' 'three,' 'four,' 'five,' 'six,' n,' 'eight,' completing the series with the *o* of the Latin em,' and the *a* of the Greek 'deca.' It is curious that out of our ten numerals should have different vowels, and the only one of them which has two syllables repeats the vowel, which is also coupled with other vowels in the additional terms I have here borrowed. This would be xcellent guide for the memory, but the notation would be ing.

means of retaining these values. For this purpose we have only to connect the vowel denoting this quantity for each element, with the consonants that are to represent its name in composition. The following table exhibits such memorial terms for the series of elements. The first column contains the accepted symbols of the elements in the usual alphabetical order of their vulgar names, as they are arranged in the first of our tables of new symbols.* In the second column are the equivalent weights; in the third are the new memorial names. In these names the letter *x*, which I put for the sound of *sh* in the word "*sh*all," always denotes the decimal point of the arithmetical notation, standing between the integral and the fractional part of the number. The vowels prefixed to those consonant element-symbols which are not naturally initials, are supposed to represent the first vowel that occurs in the ordinary name of each element; any others may be substituted for these. Of course I do not propose these as current names for the elements; for those which we have are, for the most part, good enough for present purposes: besides, the acknowledged equivalent weights of many of them may be changed with the progress of science; in such cases a vowel or two in the corresponding words would be altered.

Words expressing the Equivalent Weights of the Elements.

Al	. 9·12	. ? Almōxse ?	Be	. 4·7	. Gloxē
Sb	. 129·	. Sbaeō	Bi	. 213·	. Ibseai
As	. 75·	. Arsēu	B	. 10·9	. Baūxō
Ba		. Abma[illegible]	Br	. 80·	. Brīu

Cd	56·	Acduā	Os	99·6	Osmōōxā
Ca	20·	Alceū	O	8·	Rī
C	6·	Cā	Pd	53·3	Alduixi
Ce	47·	Ecmoē	Pe		Elp
Cl.	35·5	Cliuxu	P	32·	Fie
Cr	26·7	Creāxē	Pt	98·7	Aptōixē
Co	29·5	Bleōxu	K	39·2	Piōxe
Cu	31·7	Priaxē	R	52·2	Ormueze
D	49·6	Doōxā	Ru	52·2	Urtuexe
E		Erb	Se	39·5	Sliōxu
F	18·9	Flaīxō	Si	21·3	Sceaxi
Au	197·	Gaōē	Ag	108·1	Argaūixa
H	1·	Ha	Na	23·	Sdei
I	127·	Idnaeēxa	Sr	43·8	Sroixī
Ir	99·	Irdōō	S	16·	Saā
Fe	28·	Freī	Ta	184·	Antaīo
La	47·	Alnoē	Te	64·2	Tlāoxe
Pb	103·7	Plaūixe	Tb		Tr
Li	6·5	Lāxu	Th	59.6	Thuōxā
Mg	12·2	Maexe	Sn	59·	Snuō
Mn	27·6	Amneēxā	Tr	25·	Teu
Hg	100·	Idraūū	W	95·	Wōu
Mo	46·	Olboā	U	60·	Urnāū
Ni	29·6	Inceōxā	V	68·6	Vāixa
Nb		Inb	Y	32·	Yie
N	14·	Nao	Zn	32·6	Ziexā
No		Onr	Zr	22·4	Jeexo

In combining our elemental and numeral symbols into names for compounds, I would place those of the elements in some uniform order with respect to each other. Thus, in the names of salts, I would place the basic elements first, and the stylic members after them. In the cases of isomeric compounds, I would distinguish them either by indicating something of their constitution in their name, as may easily be done

by expressing separately some of the complex constituent molecules, or by prefixing a different vowel to the name of each, as an arbitrary characteristic. For complex molecules which seem to replace elementary atoms, or which occur very frequently as distinct members of compounds, we may have consonantal symbols, according to the practice already sanctioned by current usage. Thus, we may represent Cyanogen $= C_2N =$ Cena, by *cn*; Mellone $= C_6N_4 =$ Cāno, by *nl*; Methyl $= C_2H_3 =$ Cehi, by *mt*; Ethyl $= C_4H_5 =$ Cohu, by *Thl*; Amyl $= C_{10}H_{11} =$ Caūhaa, by *ml*; Fenyl $= C_{12}H_5 =$ Caehu, by *fn*; Kakodyl $= C_4H_6As =$ Cohārsa, by *cdl*; Acetyl $= C_4H_3 =$ Cohi, by *ct*; Water $= H:O =$ Hara, may be aptly denoted by *cw*, which is the phonetic symbol of the sound which we give to the consonants of the Latin *aqua*.

We have now to find the means of expressing, when necessary, in the name of a compound, the other important quality,—its combining tendency or chemical function. We have, in the old nomenclature of Lavoisier, an example supplied to us of the best method of effecting this, namely, the device of appending a consonant at the termination of the name. We may adopt this plan in our phonetic system; for we have determined that consonants not followed by vowels shall not denote any elementary constituent. Thus, an epibase may be marked by a final *n*; a base by a *b*; a style by an *s*; an epistyle by an *r*; a parahale by an *m*; a neutral non-saline compound of uncertain type by an *l*; a single salt with a simple base, and a simple style may be marked by a *d* at the end of the name; one with a simple base, and a style complicated with an epistyle, by a *t*; one with

a simple style, and a
base, by *nd*; one hav
by *nt*. A multiple
or duplication of the
vowel ă (= zero) be
vowel will show tha
it denotes function
scarcely necessary
function, except whe
to this point of cha
tions may generally
of an epibase and ep

The following exam

Hinan. $C_4H_3=C$

Sarir. $N,O_4=Na$

Paclad. Ba:O;SC

Hinaldarand. $(H_3;N$

$\frac{K\uparrow I}{Ag|I}$ = Pargadnedūd

ātūt. $\frac{H_3,N;H\uparrow O;}{\frac{(Al|O;}{(H|O)}}$

$H_3,N;C,O_2$ = Hin
viated consonant sy
may in some cases
may point out the
stances by indicati
Thus, we shall hav
$C_{12}H_7N$, represent

* Palmisoraāt and H
neral to express these
Alumina as Al_2O_3, may

guish them by calling the former Acaehēnan, and the latter Tcaehēnan. But since we know that Aniline contains the molecule $C_{12}H_5 = fn$, we may designate this epibase by the term Hefnanan, leaving the more general term Caehenan for its congener, of which we do not certainly know the constitution.

Again, in the case of cyanides, $(K:Cy)_2;FeCy =$ Pefracnit; a slight abbreviation only is effected. But when we put for $\left.\begin{matrix} C_{12}H_5 \\ C_2H_3 \\ C_4H_5 \end{matrix}\right\}$,N;$C_{10}H_{11}$:Br = Thlamtaf-nanamlabrand, instead of the more general term Ceïheonabrand, we gain very considerably in our scope of definition: and though this word is not remarkable for its brevity, it has great advantage in this respect over the very shortest form that can be given for it under the ordinary system: thus we have here only six syllables, while Ethymethyfenamylium-bromide, which is a considerable condensation of the shortest name usually given to such a compound, involves no less than 11, and does not distinguish it from a very possible compound containing antistylic Antimony (for example) instead of Nitrogen.

It is useless further to multiply examples, any student who thinks the system worth trying can master its principles in half an hour, and can construct for himself for all compounds, names which will be identical with those which every other person using the same mode of nomenclature must give to them.

It may, however, be worth remarking that the terminal consonants, which I have suggested, afford us general names which, as applied to groups of species, shall include all the bodies of the same form. Thus

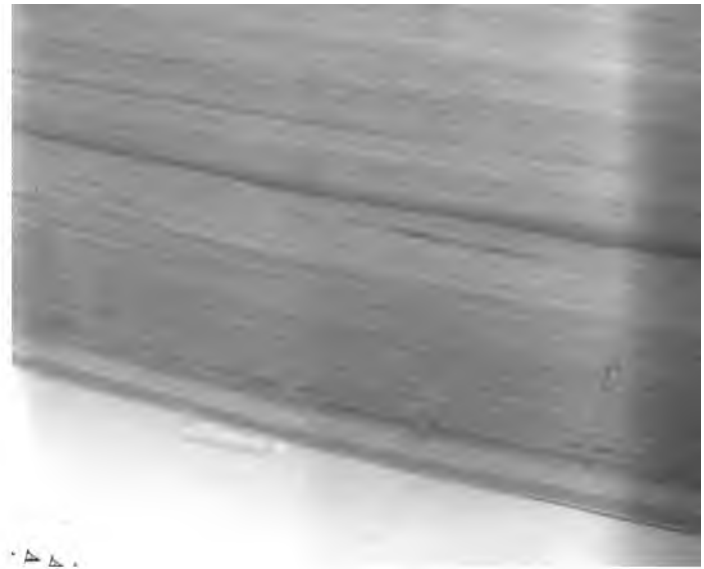
So single salts, with their
complex, will be respectively
the salts of the style $(O;SO_3)$
be the Sarots; all those of
the salts of $H_3,N;H$, with
Honands.

Single salts with complex
Ants. All such salts, for
$O;N,O_5$ would be Narrants
$(H_4C_2O_2N_2$=Hocerenen)

All haloids would be Arn
any epistyle, would be Hi
with any epibase, Sarirns.
divided into several groups,
Atats, Adats, Adands, Adan
dants, Antants, according to
single salts of which they a
substituting the vowel $\bar{u}$ (=
for a in these forms, and by
another syllable, we obtain
lies of multiple salts of more
by substituting for $\bar{u}$ the v

ūdūtūnt; and under the generic term of Eoditant, as being composed of 24 molecules of an Ad salt, 3 of an At, and 1 of an And. And the corresponding Potassium salt is of the family of ūdūts, and of the genus Eodot.

We can scarcely express the varieties of salts more clearly, certainly not more briefly, than by this arrangement.



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JOHN EDWARD TAYL
LITTLE QUEEN STREET, LINC



